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# Computer Graphics Products Softwa
# Plug-in & Portable Oscilloscopes OEM
# Data Comm Testers Logic Analyzers
# GPIB Programmable Instruments Acq
# sition/Processing Systems Semicond
# Test Systems Curve Tracers Cable Te
# ers Microcomputer Development Pro
# TV Demodulators Vectorscopes Gen
# ators Waveform Monitors Cable Test
# ntelligent Graphics Workstations Spe
# um Analyzers & Swept Frequency Sy
# Digitizers TDR Photometer/Radiomet
# Cameras Probes Carts & Accessories

Tektronix®
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Color identifies *NEW* products.

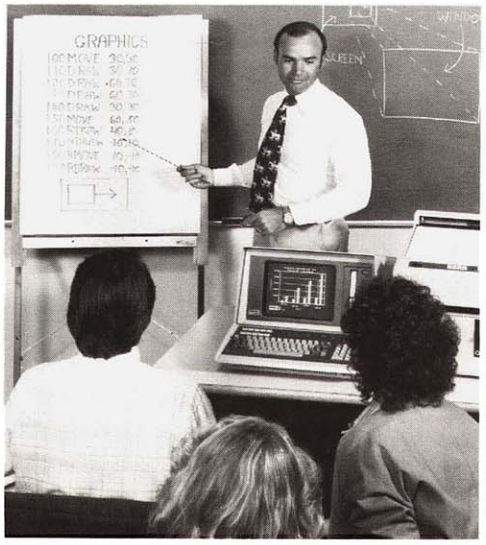
# CUSTOMER SERVICES AND INFORMATION

## Tektronix Means . . .Fast, Flexible Worldwide Support

**Get sales information and assistance to evaluate and order the products you want.**
Ask for a Customer Service Representative the first time you contact Tektronix. The CSR can give you information on products and the names of the Sales Engineers assigned to serve your product interests. Tektronix Sales Engineers will respond to your technical and business inquiries.

Sales Engineers can give you information on dozens of products, so that you can select the one model best suited to your present and future applications, and will be happy to arrange a demonstration of that product.

Your Customer Service Representative or Sales Engineer can provide you with information on prices, terms, delivery dates, shipping estimates and best means of shipping.




**Customer-site installations are thorough.**
Tektronix provides on-site installation for most computer graphics products and most Tek-configured systems for computer graphics, semiconductor test, microprocessor development, and acquisition-/processing. The Tektronix service specialist will make sure your equipment is set up properly with all functions operating to spec, and will walk you through the basics of its performance.

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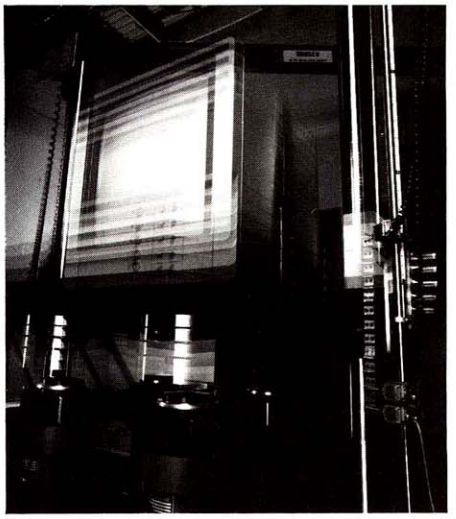
Sales and Service Offices . Inside Back Cover


**The people behind the product are friendly and ready to help you.**

**Training and assistance gets users up to speed, fast.**
Your Tektronix product is most useful to you when you're thoroughly familiar with it. Ask your Sales Engineer for a demonstration. If several people plan to use the products, your Sales Engineer will conduct an informal class about the product and its operation at your location. Tektronix also offers formal classes and self-study aides. Ask your Sales Engineer for details about Customer Training.

## Check the Specifications. You'll Find Long Product Life Designed-In.



### Reliability Standards Second to None

Tek products are engineered for high reliability from the initial stages of design. Components and assembled products of every prototype and preproduction model are subjected to "accelerated-life" reliability tests in our Labs. If any fall short of Tek Standards, changes are made.

Manufactured products are thoroughly tested before they're fitted in custom-designed, lab-tested shipping cartons.

### Product Specifications to Meet Your Environment

In Tek's Environmental Labs, field conditions are taken to extremes. Shock, vibration, high humidity, electromagnetic radiation, electrostatic discharge, power line surge, high/low temperature and altitude tests are conducted.

The environmental characteristics listed among the product specifications in this catalog may include some or all of the above types. The specification limits for humidity, vibration, shock and transportation are intended to be beyond what is expected in use. Operation at these extremes may cause minor physical deterioration but should not cause electrical performance to deteriorate outside specifications. Continual use at the specified limits of temperature and altitude should not cause significant short-term deterioration. Higher temperature will reduce long-term reliability. The EMC test is completely nondestructive.

## GENERAL TERMS OF SALE

### Credit and Payment Terms

Tektronix, Inc. offers many different terms of sale in order to meet varied purchasing objectives and to assist in financial planning.

Credit accommodations must be arranged with Tektronix's Credit Department. Orders and request for credit accommodations should be placed with your local Tektronix Sales Office, listed on the inside back cover.

If, in the judgement of Tektronix, the financial condition or payment record of the Buyer at any time does not justify shipment of order on the payment terms requested, Tektronix may refuse to ship unless it receives payment in advance, or at its option, payment upon delivery of equipment. Businesses established for six months or less may not meet minimum requirements for extended and/or installment terms of sale.

The following terms may be arranged with a Tektronix Sales Office:

### Net 30 Days Standard Terms

Standard terms of sale are Net 30 days following the date of invoice. There are no discounts for early payment.

### 60, 90 and 120 Days Extended Terms of Sale

Extended terms of 60 to 120 days are available on the same single payment basis as standard terms. Since the cost of extended terms is not included in catalog prices, a service charge is added to the invoice. The amount of the service charge depends upon the number of days the terms are extended. Request for extended terms must be made at the time of order placement.

### Installment Purchases—Security and Lease Agreements

This program provides monthly installment payment terms while Tektronix Products are in use. Accessories and parts are not available unless they are associated with the products being purchased. New and used products may be purchased with a deduction for applicable quantity discounts.

Security and Lease terms are not invoiced. Reminders of each installment are sent to the customer 10 days prior to the due date. The due date of each monthly payment on an installment term will be approximately 30 days from the date of shipment and every 30 days thereafter until completion of the contracted term. Failure to receive any reminder notice from Tektronix shall not affect customer's obligation to pay charges when due.

Except for standard warranty, maintenance is not provided under either a Security Agreement or a Lease Agreement. Additional maintenance is not provided under either a Security Agreement or a Lease Agreement. Additional maintenance coverage may be purchased where offered as an option to the instrument or may be purchased as a separate transaction. Maintenance ordered as an option may be financed along with the product.

The customer is required to pay applicable property taxes, licenses, etc. and furnish adequate insurance to Tektronix for loss and damages for both Leases and Security Agreements.

### Security Agreement

An advance payment equal to approximately 10% of the purchase price of the equipment desired is required for a Security Agreement. Installment terms covering the balance of the contract price are available for 6, 12, 18, 24, 30, or 36 months.

Minimum balance amounts may be financed, ranging from $1000 for six months to $2000 for thirty-six months. Longer terms of 48 months to 60 months are available by quotation for financed balances of more than $25,000. There are no maximum finance balances. Upon completion of the term of the Security Agreement and prescribed payments, the customer owns the equipment.

### Lease Agreement (Minimum is $1,000)

A standard lease term of 6, 12, 18, 24, 30, and 36 months is offered. Longer terms are negotiable. Under a Lease Agreement the customer pays for the use of the product for the term of agreement. It is not a month-to-month rental . . . it is a non-cancellable, fixed-term lease requiring no advance payment. At the expiration of the lease there is the opportunity to update the instruments, to renew the existing lease, or to return the equipment at the expense of Tektronix, Inc. The customer may exercise an option to purchase the equipment at any time during the term of the lease, provided he gives thirty days written notice. A portion of the installments will be credited toward the purchase price.

### Computer Graphics Products

Most Computer Graphics Products are also available under an operating lease program. The minimum fixed terms of this program are 12, 24, 36 months, or longer. Automatic extension on a month-to-month basis is also available after the fixed minimum term. Equipment leased on this program is maintained by Tektronix, Inc. during the terms of the agreement. Rental of Computer Graphics Products for customer evaluation is available for periods of 90 or more days.

During the term of the operating leases or rentals described, the customer may exercise an option to purchase the equipment provided 30 days notice is given. A portion of the installments already paid will be credited toward the purchase price. Questions regarding warranty should be discussed with your Tektronix Sales Engineer.

### Minimum Order

The minimum acceptable order is $25.00.

### Shipment

All prices, quotations, and shipments are FOB Beaverton, Oregon, unless otherwise specified.

Unless otherwise specified, shipment will be made via most economical method and air shipments will be insured at full valuation unless your order instructs otherwise.

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## HARDWARE WARRANTY SUMMARY

Tektronix warrants to its Customers that the products that it manufactures and sells will be free from defects in materials and workmanship for the periods set forth in the table below. If any such product proves defective during the applicable warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Tektronix will provide such service at Customer's site for certain categories of products, as indicated in the table below, if Customer's site is within the normal on-site service area. Tektronix will provide on-site service outside the normal on-site service area only upon prior agreement and subject to payment of all travel expenses by Customer. In all other cases, Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the service center is located. Customer shall be responsible for paying all shipping charges, duties and taxes, if the product is returned to any other location. The locations at which the services will be provided for different categories of products or product groups are set forth below.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modiified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

**THIS WARRANTY IS GIVEN BY TEKTRONIX WITH RESPECT TO THE LISTED PRODUCTS IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. TEKTRONIX DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO REPAIR OR REPLACE A DEFECTIVE PRODUCT IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX HAS ADVANCE NOTICE OF THE POSSIBLITY OF SUCH DAMAGES.**

| PRODUCT CATEGORIES | WARRANTY PERIOD | SERVICE LOCATION |
|---|---|---|
| Oscilloscopes (except 2200, 2300, 2400 Series) and Plug-ins; TM 500/TM 5000 General Purpose Instruments; Communications Network Analyzers (except 834 Series); Logic Analyzers; Spectrum Analyzers (except 494 and 494P); Television Products (except 1980 and 650 and 690 Series); Waveform Digitizers; Curve Tracers; Photometers/ Radiometers; Cameras; Carts; Probes; CRTs; and Isolators | 1 year from date of shipment | Service Center designated by Tektronix |
| Oscilloscopes: 2200, 2300, 2400 Series; Spectrum Analyzers: 494 and 494P; Monitors: 650 and 690 Series; Communications Network Analyzers: 834 Series and 067-0986-00 | 3 years from date of shipment | Service Center designated by Tektronix |
| Monitors: 602, 603, 606, 608, 620, 624, 634; | 3 months, except 1 year from date of shipment for CRT | Service Center designated by Tektronix |
| Computer Graphics Products (except 4105, 4106, 4107, 4109); Intelligent Graphics Workstations; Monitors: 611, 613, 614, 616, 618, GMA 301, GMA 304; 1980 ANSWER; 4041 Controller; Microcomputer Development Products; Artificial Intelligence System 4404 | 3 months, except 1 year from date of shipment for CRT | Customer's site if within normal on-site service area |
| Computer Graphics Products: 4105, 4106, 4107, 4109 | 1 year from date of shipment | Customer's site if within normal on-site service area |
| Acquisition/Processing Systems; Semiconductor Test Systems | 3 months, except 1 year for CRT, beginning on the date of installation by Tektronix, or one month from date of shipment, whichever is earlier | Customer's site if within normal on-site service area |
| Parts, Assemblies, Supplies and Test Fixtures: All 9-digit part numbered items except Probes, CRTs, and 067-0986-00 | 3 months from date of shipment | Service Center designated by Tektronix |
| Service | 3 months from date of shipment or date of completion if performed on-site | Location where original service was performed |

## SOFTWARE WARRANTY SUMMARY

Tektronix warrants that any software product for which Tektronix publishes a corresponding "Software Product Description" will conform to the specifications set forth in the Software Product Description, when used properly in the specified operating environment, for a period of three (3) months. The warranty period begins on the date of shipment, except that if the program is installed by Tektronix, the warranty period begins on the date of installation or one month after the date of shipment, whichever is earlier. If any such software product does not conform as warranted, Tektronix will provide the remedial services specified in the applicable Software Product Descriptions. Tektronix does not warrant that the functions contained in the software product will meet Customer's requirements or that operation of the programs will be uninterrupted or error-free or that all errors will be corrected. Software products for which Tektronix does not publish a Software Product Description, or for which Tektronix does not set forth specifications in the Software Product Description, are provided "as is" without warranty of any kind, either express or implied; except that, Tektronix warrants that the media on which such software products are provided will be free from defects in materials and workmanship for a period of three (3) months from the date of shipment. If any such medium proves defective during this warranty period, Tektronix will provide a replacement in exchange for the defective medium.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for such service in accordance with the instructions received from Tektronix. If Tektronix is unable, within a reasonable time after receipt of such notice, to provide the remedial services specified in the applicable Software Product Description, when such services are indicated, or provide a replacement that is free from defects in materials and workmanship, Customer may terminate the license for the software product and return the software product and any associated materials to Tektronix for credit or refund.

This warranty shall not apply to any software product that has been modified or altered by Customer. Tektronix shall not be obligated to furnish service under this warranty with respect to any software product a) that is used in an operating environment other than that specified or in a manner inconsistent with the User's Manual and documentation or b) when the software product has been integrated with other software if the result of such integration increases the time or difficulty of analyzing or servicing the software product or the problems ascribed to the software product.

**THIS WARRANTY IS GIVEN BY TEKTRONIX WITH RESPECT TO THE LISTED PRODUCTS IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. TEKTRONIX DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO PROVIDE REMEDIAL SERVICE WHEN SPECIFIED, REPLACE DEFECTIVE MEDIA, OR REFUND CUSTOMER'S PAYMENT IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.**

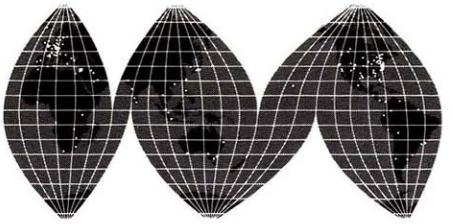
**For further details regarding OEM or specific hardware or software warranties, please consult your local Sales Office.**

## Quality Service. Quick Response. Tailored to Your Needs. Worldwide.

**Quality First, For Performance That Lasts.** Tektronix has a reputation for producing reliable products and supporting those products with a dedicated service organization for over 35 years. We know that fast, fixed-the-first-time service is important to you. Tek stands ready to help you receive the highest return for your equipment investment.

Some 1,400 people are exclusively dedicated to servicing Tektronix products. Tek Service Specialists are thoroughly trained professionals. To support their efforts, Tek has made a major investment in facilities and equipment, including our own state-of-the-art diagnostic equipment, both local and remote, and maintains a computer-controlled inventory of genuine Tek parts to ensure local availability.

**A Comprehensive Warranty.** With the purchase of any serialized Tektronix product comes Tektronix warranty coverage: All parts and labor as specified on page 11.



**Service Around the Globe.** Our worldwide service network offers technical back-up to keep your Tektronix products and software running as reliably as the day they were installed. Tektronix products are supported by Service Offices in over 60 countries.

***Warranty-Plus.*** With some products, low-cost *Warranty-Plus* Service Options are offered at the time of purchase to extend service coverage. These options are described on pages 14 and 15.

**Annual Support Agreements.** Tektronix offers sustained, flexible support for maximum uptime and long product life through Annual Customer-Site and Service Center Support Agreements. Choose the level of coverage and options that meet your needs.

**Long-Term Product Support.** Our intent is to provide full service support for six years from the publication date of the catalog in which the product last appeared. Time and material service, support agreements, FIRM PRICE repair and calibration services, together with the unique replacement parts needed, will be available to preserve your equipment.

For the succeeding three years, we plan to provide full support and parts, though service may be limited to designated service centers and take longer to complete.

Following these nine years, we will use our best efforts to continue support if experienced technicians and the necessary parts are available.

**Contact Your Tektronix Service Representative.** For prices, availability and specifics for the following programs and services in your area or country, contact your local Tektronix Sales, Service or Distributor Office. Not all programs listed on pages 12 through 15 are offered in every country. And, Custom Agreements with additional services such as pick-up/delivery, automatic recall, and multi-shift coverage are available at selected offices. Please ask for details at the office nearest you.

## SELF-MAINTENANCE SUPPORT

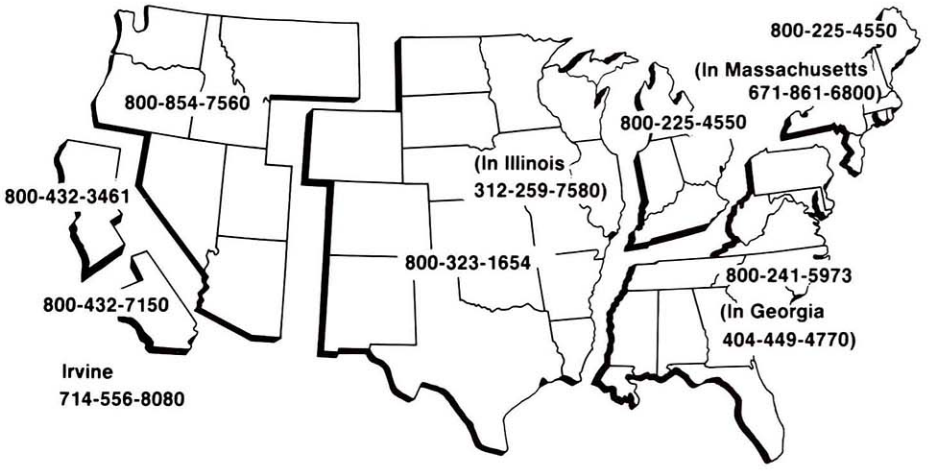
We support the efforts of customers who choose to perform their own maintenance.

**Parts, Spares, Supplies, and Accessories.** For the fastest possible service, phone the part name, product model and serial numbers to the Tektronix Direct Parts Order Desk for your area. (See map for toll-free numbers. Outside the continental United States, contact your nearest Tektronix Sales and Service Office.)

**Module Repair and Return.** Specified modules for information display products and Tek-configured systems may be sent to our Factory Service Center in Beaverton, Oregon for repair. Turnaround is good on this cost-effective and convenient means of service.

**Provisioning (Service Sparing).** To assure you of an efficient inventory of stock on hand, Tektronix will recommend packaged spares for individual products or product groups (based on experienced field failure data) and provide them according to your specifications.

**Service Training.** You can learn from Tektronix. We've established a comprehensive Customer Service Training Program of classes and self-study aids on subjects such as instrument operation, circuit description, calibration, basic concepts and applications. Formal classroom training is offered at several Tek locations around the world. In some cases, training can be arranged at your site. You may also order from our library of independent study aids. Audiotapes, videotapes, and printed materials are available. Just obtain a copy of our CUSTOMER SERVICE TRAINING CATALOG from your nearest Tektronix Office or complete the reply card in this catalog.




*For your convenience, you may order parts directly by calling the desk at the toll-free number for your area.*

## Service Publications.

For every Tektronix product there is a Service Manual with circuit schematics, parts lists, operating, maintenance and troubleshooting information available in hard copy form or on microfiche.

**Hard Copy.** Order as you would for any part. You can also receive TEKNOTES (our periodic newsletter on service) by asking your Tektronix Representative.

**Microfiche.** All microfiche is ANSI standard 105 mm x 148 mm. Order information by specific product, entire group or product line series, or as a full set of all Tektronix products. A one year subscription to receive new and revised information is available on group, product line series, or full-set orders. To order, contact CPO Field Office.

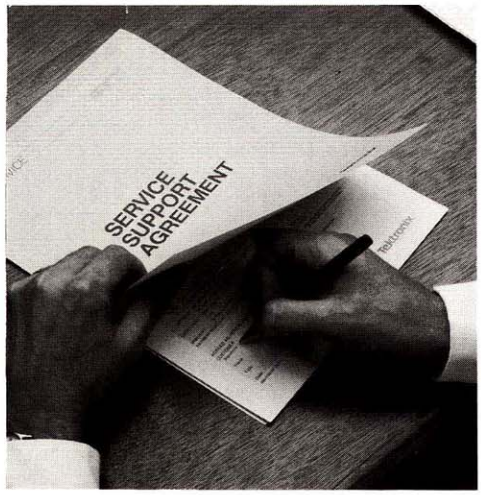
## CUSTOMER-SITE SUPPORT FOR TEK DESIGN AND TEST SYSTEMS AND INFORMATION DISPLAY PRODUCTS

**Annual Agreements**
Maintenance Agreements are available for Tek-configured Systems and all Information Display Products.

Agreements cover parts, labor and travel. To replace a CRT or simply adjust it, and to further minimize downtime, Customer-Site Agreements include the appropriate number of annual, planned maintenance calls for your product. Our inspections and parts replacements, including CRT, are thorough. We give meticulous attention to such details as optimized fine-tuning, cleaning, and making sure operation has been restored to your satisfaction before leaving your area.

Our customer-site response target is "same day service," within eight work-hours, with few exceptions. Our objective is to maximize your uptime.

For faster response, multi-shift or weekend coverage, ask about our custom service agreements. We want your business and we're flexible.




**Per Call Service**
Fast service is available for Tek-configured systems and most computer graphics products on a time-and-material plus travel basis. The same quality of service offered under Agreement coverage is provided and warranted for 90 days.

**Software Support**
**Achieve System Productivity Goals Quickly with Tek's Technical Assistance Services (TAS).** We'll provide short-term, on-site consultation to help you implement Tektronix software, train users, and solve application problems. A Tektronix System Analyst is available to help define the scope of assistance needed before any cost is incurred.

**Software Subscription Services (SSS) Keep Your Programs Current.** Subscribers to SSS receive the most current releases of Tektronix licensed software products, and updates to software documentation. SSS is available at the time you order new software. If you subscribe at a later date, you'll receive the latest release of your original software.

## SERVICE CENTER SUPPORT FOR INSTRUMENTATION AND TELEVISION PRODUCTS

**Annual Agreements**

1. **Calibration Support Agreements** provide one or more scheduled calibrations. If light use warrants little concern for failure, and your main concern is accuracy, choose this agreement.
2. **Standard Support Agreements** provide the most complete assurance that your instrumentation performs to published specifications day in, day out. Coverage includes one scheduled calibration, a thorough inspection, cleaning, and complete repair coverage with the single exclusion of CRT repair or replacement. Light CRT use? No CRT? Choose Standard support for accuracy and maximum uptime.
3. **Total Support Agreements** add CRT coverage to Standard Support. If accuracy and CRT performance are critical, and budget adherence strict, choose Total Support.

**Optional Add-on Services.** If your agreement already includes one calibration, you can add on additional calibrations, certification traceable to NBS, or before-and-after Test Data.

4. **Basic Support Agreements** serve applications where accuracy is important, but not critical. You'll receive priority service and a calibration with each repair when you need it.
5. **Remedial Support Agreements** restore equipment to an operable state in event of failure. They do not cover problems which require calibration to define or correct. If your instrument is used as a troubleshooting indicator, or if only one function is critical, Remedial Support may be all you need.

| Annual Agreement Type | Minor Cleaning Cosmetics | Repair Labor | Non-CRT Repair Parts | CRT Coverage | Mod Updates | Scheduled Cal | Cal Labor | Cal Certification*1 | Before-&-After Test Data*1 | Add'l Cals*1 |
|---|---|---|---|---|---|---|---|---|---|---|
| CAL-ONLY | ■ | | | | | ■ | ■ | ■*1 | ■*1 | ■*1 |
| STANDARD | ■ | ■ | ■ | | ■ | ■ | ■ | ■*1 | ■*1 | ■*1 |
| TOTAL | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■*1 | ■*1 | ■*1 |
| BASIC | ■ | ■ | ■ | | ■ | | ■ | | | |
| REMEDIAL | ■ | ■ | ■ | | Limited | | | | | |

*1 *Optional*

**Per-Incident Repairs and Calibration**

**Firm Price Service** gives you in advance, the exact cost to repair and/or calibrate/performance test most Tek Instrumentation Products at the Service Center. If it takes less than an hour's labor and under $10 in parts for the repair, only the Mini-Repair Fee is charged. And all Firm Price Services are warranted for 90 days. You can sign up for some service agreements during this period and receive an "early sign-up" discount.

**Time-and-Material Service at the Service Center is Available for Damaged or Discontinued Products.** Abused, damaged and discontinued products excluded from the Firm Price Program and Per-Call service may be repaired on a time-and-material basis. Please obtain instructions from your nearest Tektronix office before shipping equipment or parts.

## *Warranty-Plus* is Your Best Service Value.

*Warranty-Plus* coverage ensures full value for your investment from the start by extending maximum uptime long after your warranty expires.

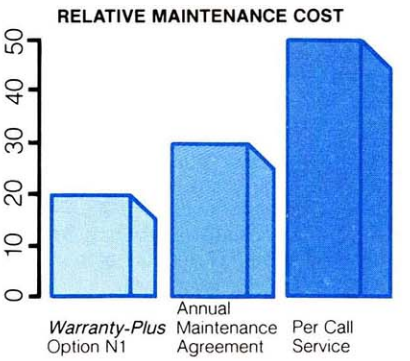
*Warranty-Plus* helps you manage your maintenance costs with just one, up-front product option charge. Pay it with your purchase. Forget about service costs for one year or, in some cases, up to five years. Nothing makes budget planning easier.

The relatively low cost of *Warranty-Plus* Options reflects our confidence in the high reliability of our products.

*Warranty-Plus* is your most cost-effective means of planned maintenance. *Warranty-Plus* fixes your service costs, no matter how much service rates may increase.

And, unlike annual maintenance agreements, there is only one *Warranty-Plus* price per product, with no additional charge for the extra equipment options you may select.

*Warranty-Plus* provides fast, priority service without delays for approvals or paperwork. That means more uptime.




## CUSTOMER-SITE "N" OPTIONS FOR MOST INFORMATION DISPLAY PRODUCTS AND TEK-CONFIGURED SYSTEMS

**Standard Sale Option N0 (N 'Zero') Installation and Setup.**

***Warranty-Plus* Installation N0**

For any Tektronix Product with N1, N2, or N3 *Warranty-Plus* Options, Tektronix will install, setup and verify performance at the customer's site when Option N0 (N 'zero') is ordered at the time of product purchase. All labor and travel are included. Some additional travel expense may be billed outside 150 miles from the service office. Installation is also available for OEM puchases under Option N4.

**Standard Sale Option N1. First Year's Service Coverage.**

**CUSTOMER SITE SERVICE FOR MOST INFORMATION DISPLAY PRODUCTS AND TEK CONFIGURED SYSTEMS**

| Month of Ownership | 1 2 3 | 4 5 6 | 7 8 9 | 10 11 12 |
|---|---|---|---|---|
| Warranty Only | Warranty Coverage | | | |
| *Warranty-Plus* Option N1 | Warranty Coverage | *Warranty-Plus* Coverage Planned Maintenance Call(s) | | |

***Warranty-Plus* Customer-Site Support Option N1**

For about the cost of one customer-site service call, you can extend 90-day service coverage on most Information Display Products, Microprocessor Development Systems, and Engineering Computing Systems to a full year. Just request *Warranty-Plus*, Option N1, at the time you place your product order. It covers travel, modules, all parts (including CRT) and labor to keep your equipment functioning to published specs for one year. Plus the appropriate number of planned maintenance calls to inspect, test, clean and adjust your equipment to optimum performance. This includes maintaining mechanically-based copiers, plotters and disk drives, running diagnostics and verifications on computing systems, as well as adjusting sharpness, resolution or convergence of DVST and raster CRTs.

***Warranty-Plus*** Option N1 is only available with standard end-user sales of most Information Display products, and Tek configured systems, and only at the time of product purchase. Specify "Option N1" when ordering.

**Standard Sale Option N2. First Three Year's Service Coverage.**

**CUSTOMER SITE SERVICE FOR 4105, 4106, 4107, and 4109 COLOR TERMINALS**

| Year of Ownership | 1 | 2 | 3 |
|---|---|---|---|
| Warranty Only | Warranty Coverage | | |
| *Warranty-Plus* Option N2 | Warranty Coverage | *Warranty-Plus* Coverage | |

***Warranty-Plus* Customer-Site Support Option N2**

Our 4105, 4107, 4109, and *NEW* 4106 Color Terminals are so reliable that each is covered by a New Product Customer-Site Service Warranty for one full year. What's more, we're so confident of their reliability that we'll extend your coverage for two more years at a price so low it breaks industry barriers.

Customer-Site coverage for both the 2nd and 3rd year costs less than one average service call. Less than an annual service contract you may purchase later. And only a fraction of the standard, one-time repair-and-adjustment fee. Option N2 covers travel, modules, parts, CRT, and labor.

***Warranty-Plus*** Option N2 is only available on the 4105, 4106, 4107, and 4109 terminals and only at time of product purchase. Specify "Option N2" when ordering.

**OEM Sale or Standard Rental Buyout Option N3. First Year's Service Coverage.**

**FIRST YEAR ON-SITE SERVICE FOR OEM SALES**

| Month of Ownership | 1 2 3 | 4 5 6 | 7 8 9 | 10 11 12 |
|---|---|---|---|---|
| Warranty Only | Warranty Coverage (Depot Service) | | | |
| *Warranty-Plus* Option N3 | *Warranty-Plus* Coverage (On-Site Service, Travel Included, Transferable to end-user) Planned Maintenance Call(s) | | | |

***Warranty-Plus* First Year On-Site Service Option N3**

For OEMs, *Warranty-Plus* Option N3 displaces the normal 3-month depot-service warranty with a full year of priority, on-site service. Besides adding nine more months of coverage, Option N3 includes planned maintenance calls. All this is transferable to the end-user. For Standard Rental Buyout customers, *Warranty-Plus* Option N3 offers 12 months of on-site coverage from the date of purchase, since no warranty is available on Rental Buyouts.

For OEMs, a liaison within the OEM organization provides Tektronix with the location of products and other logistics to fulfill our agreement. OEMs may elect to renew coverage on behalf of their customers. Custom mods are ineligible if they increase time or difficulty in servicing a product. Ask your Tektronix representative to review your modifications for eligibility.

***Warranty-Plus*** Option N3 is only available with OEM sales of end-user type Information Display products or Standard Rental Buyouts, and only at the time of product purchase. On the 4105, 4106, 4107, and 4109 terminals, the Option N2 can be added to Option N3. Specify "Option N3" or "Option N3 with Option N2" when ordering.

**International *Warranty-Plus* Options, Customer Responsibilities and Coverage Exclusions.**
*Warranty-Plus* is available in most countries, but service is only provided in the country where the product and plan are purchased. *Warranty-Plus* Service purchased in the United States is only valid within the United States.

In the United States, service is performed during normal business hours. For most Information Display Products or Tek-configured Systems, service is provided at the customer's site with no travel charges, within eight work hours of notification, if the site is within 150 miles of a Tektronix Service Center. If not, response may be longer.

Our 2000 Family portable oscilloscopes and the 494/494P Spectrum Analyzers receive priority service at a Tek Service Center. Under Options M1, M2, M3, M4, and M5, it is the customer's responsibility to deliver the product for servicing at the Service Center designated by Tektronix, with shipping charges prepaid. Return shipping is paid by Tektronix.

Outside the United States, response and turnaround times may be different. Consult the Tek subsidiary or approved distributor in your country.

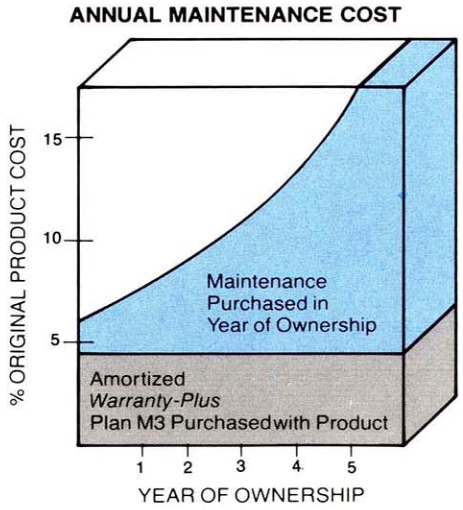
As you may expect, service under a *Warranty-Plus* Agreement does not apply if the failure is caused by misuse or inadequate care or maintenance, such as:
a) damage from repair attempts by non-Tektronix personnel;
b) improper use or connection to incompatible equipment; or
c) modification or integration that increases time or difficulty in servicing your product.

## SERVICE CENTER "M" OPTIONS FOR 2000 SERIES PORTABLE OSCILLOSCOPES AND 494/494P PORTABLE SPECTRUM ANALYZERS

***Warranty-Plus* Service Center Support Options.** As strong testimony to the incomparable reliability of the 2000 Series of Tektronix portable oscilloscopes and the 494/494P Spectrum Analyzers, Tek offers a **three year warranty**—the first offered by any major instrumentation manufacturer to do so. Now, beyond the "basic three years"—Tek will extend service coverage up to five years, offering you a choice of three practical *Warranty-Plus* Service Center Support Options to meet your needs.

**One Up-Front Fee Pays for Itself and More.** *Warranty-Plus* costs less than annual contracts for the same service you may purchase later. And far below standard repair or single calibration costs.

You also save money because your contract will limit your costs, no matter how much service rates may increase.




You'll get more uptime, too, because with a *Warranty-Plus* Service Plan, you won't experience delays in needed service because of unplanned expense, approvals, or paperwork.

Tek helps you manage your maintenance costs with just one, known, up-front charge.

Optional *Warranty-Plus* Plans are only available on 2000 Family portable oscilloscopes and the 494/494P Spectrum Analyzers, and only at the time of product purchase. Specify "Option M1" "Option M2" or "Option M3" when ordering.

| Year of Ownership | | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|---|
| Warranty | | Warranty Coverage | Warranty Coverage | Warranty Coverage | — | — | |
| Optional ***Warranty-Plus*** Service | Plan M1 | — | 1 Calibration | 1 Calibration | — | — | ***Warranty-Plus* Option M1**. Provides two routine calibrations to published specifications, one each in years two and three of Warranty coverage. |
| | Plan M2 | — | — | — | Remedial Coverage | Remedial Coverage | ***Warranty-Plus* Option M2**. Provides two years coverage of Remedial Service which includes repair service labor (except calibration) and parts (except CRT) in years four and five of product ownership. |
| | Plan M3 | — | 1 Calibration | 1 Calibration | 1 Calibration + Remedial Coverage | 1 Calibration + Remedial Coverage | ***Warranty-Plus* Option M3.** Provides for four years of routine calibrations, one each in years two, three, four, and five of product ownership. During years four and five, annual calibrations may be performed at the time of repair in the event of failure or at a scheduled date independent of repair, per customer's request, but not both. |
| | Plan M4 | 1 Calibration with Certification | 2 Calibrations with Certification | 2 Calibrations with Certification | — | — | ***Warranty-Plus* Option M4.** Provides five routine calibrations, one in year one, two each in years two and three, all certified (in U.S. traceable to NBS). |
| | Plan M5 | 1 Calibration with Certification | 2 Calibrations with Certification | 2 Calibrations with Certification | 2 Calibrations with Certification + Remedial Coverage | 2 Calibrations with Certification + Remedial Coverage | ***Warranty-Plus* Option M5.** Provides nine routine calibrations certified (in U.S. traceable to NBS) over the first five years of product ownership: one in year one, two each in years two through five. Plus, remedial support coverage for years four and five. |

## OEM COMPONENTS

**Special Information for OEM**
At Tektronix we offer many products with terms, conditions, and pricing for OEMs. Computer graphics components, small screen displays, certain cameras, tv signal test and measurement instrumentation—we offer these and other products on a special basis to the original equipment manufacturer.

But terms and conditions tell only part of the Tektronix OEM story. Our products have the quality, reliability, and top performance per dollar that the OEM needs to stay competitive.

**Choose The Performance Level To Match Your System**
In many product areas our wide range of OEM components allows you to select just the optimal performance you need for the system you are building. When your systems demand highest performance, Tektronix will provide the quality products to meet your standards.

In price-sensitive situations, the wide Tektronix selection usually lets you select exactly the performance level you need—no more, no less.

**Special OEM Terms and Pricing Help Keep You Competitive**
Ask your local Tektronix representative about the special OEM terms and pricing available to you.

**Service and Support— When and Where You Need It**
Tektronix has service centers throughout the U.S. and in many countries around the world. We offer long term parts support to protect your investment.

If you need applications assistance, we're ready to help. Our OEM specialists are trained to help solve interface problems. That's solid support when you need it.

**You and Tektronix: A Quality Partnership**
Explore the advantages of working with Tektronix: excellence in products, support, and service.

Your local Tektronix representative can help you obtain full details on how you can profit from a quality partnership with Tektronix.

See how our OEM expertise can add value to your system.

## POWER SOURCE CONSIDERATIONS

Most Tektronix instruments provide wide-range regulated supplies, or quick change line-voltage selectors for convenient selection of line-voltage operating ranges. Transformer taps in other instruments can be changed to accommodate specific line-voltage operating ranges or can be factory wired for a specific range if specified on the purchase order.

Many Tektronix instruments are designed to operate from a power source that will not apply more than 250 Volts RMS between the supply conductors or between either supply conductor and ground.

Many Tektronix instruments can be fitted with one of the power cord/plug options listed below and wired for the voltage as indicated, if specified on the purchase order.

| | | |
|---|---|---|
| North American | 120 V/15 A | Standard |
| Universal Euro | 220 V/16 A | Option A1 |
| United Kingdom | 240 V/13 A | Option A2 |
| Australian | 240 V/10 A | Option A3 |
| North American | 240 V/15 A | Option A4 |
| Switzerland | 220 V/10 A | Option A5 |

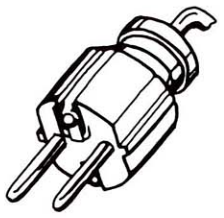
The power cord/plug options may become available on instruments not specified in this catalog. Refer to the individual product ordering information for those products offering these options as of publication date.

Except for some double-insulated instruments, most Tektronix instruments are equipped with either a three-conductor attached power cord or a three-terminal power-cord receptacle. The third wire or terminal is connected directly to the instrument chassis to protect operating personnel.

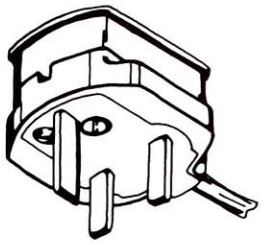
Power-cord coding follows one of the two following schemes:

| | Scheme 1 | Scheme 2 |
|---|---|---|
| Line | Black | Brown |
| Neutral | White | Light blue |
| Ground (safety earth) | Green-yellow | Green-yellow |

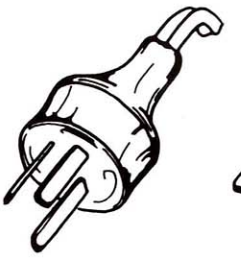
**Standard**
**North American**
**120 V/15 A**



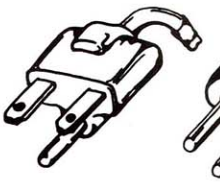
**Option A1**
**Universal Euro**
**220 V/16 A**



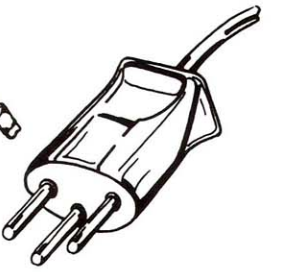
**Option A2**
**UK**
**240 V/13 A**



**Option A3**
**Australian**
**240 V/10 A**



**Option A4**
**North American**
**240 V/15 A**



**Option A5**
**Switzerland**
**220 V/10 A**

## TEK Means...Getting the picture

**with color enhancement, the power of intelligence, system integration, software and more . . .**

**Display Technology — an integral part of our business**

For almost four decades, Tektronix has designed and manufactured advanced electronic products, starting with cathode-ray oscilloscopes. Our innovative design efforts developed features such as the flat-faced CRT, the direct-view storage tube (DVST), the high-resolution liquid crystal shutter display (shown above), and the microchannel-plate CRT. The latter is incorporated in our 7104 "Gigahertz" oscilloscope, which remains unapproached in bandwidth and performance after five years in the marketplace.

**We're the leader**

We placed affordable graphics in the hands of engineers and scientists in 1971, using our experience in DVST design, (in lieu of the then high-cost of computer memory). Our PLOT 10 software early on became the de facto standard. Today, Tek PLOT 10 is installed on more computers than any other graphics utility library in the world. Our up-to-date graphics line covers a broad spectrum of needs.

Color aids in differentiating dense graphics. Displays with default color tables (and color interfaces to modify colors to your specific application) eliminate viewability problems. Our Imaging Research Lab is developing standards based on human perception and reaction to color.

**Meeting Expanding Customer Needs**

Our products are developed to fill your needs. Tek continues as an industry leader for product line breadth, range of price/performance options, and service support. Tek innovation, reliability and flexibility are built into all our products, which continue to set standards around the world.

**Our Products Have a Lot to Display**

Computer graphics is no longer constrained to simply drawing pictures or plotting data, but is emerging as an effective, efficient human interface to computers.

The high quality graphic capabilities that were made available to an extensive line of host-based graphic terminals are now available in powerful new intelligent workstations (large photo). Tedious manual digitization of engineering drawings is eliminated with a Tek graphic input workstation. And, Tek color copiers produce hardcopy with resolutions that exceed terminal resolution. Our new artificial intelligence system increases productivity in many areas of Research & Development including expert systems, natural languages, and automatic programming. Our color terminals enhance operation in a number of areas, such as single key stroke access to the powerful TNIX operating system and Tek's microcomputer design tools. Here, softkeys simplify command entry and minimize keystrokes. A choice of color terminals is also offered for our new line of acquisition/processing measurement systems. Our newest spectrum analyzer even provides a CRT display of operator "helps," in a choice of plain English, plus optional French, German, or Spanish. This year, more than any other, we've got a lot to display.

## Information Processing

### Intelligent Graphic Workstations

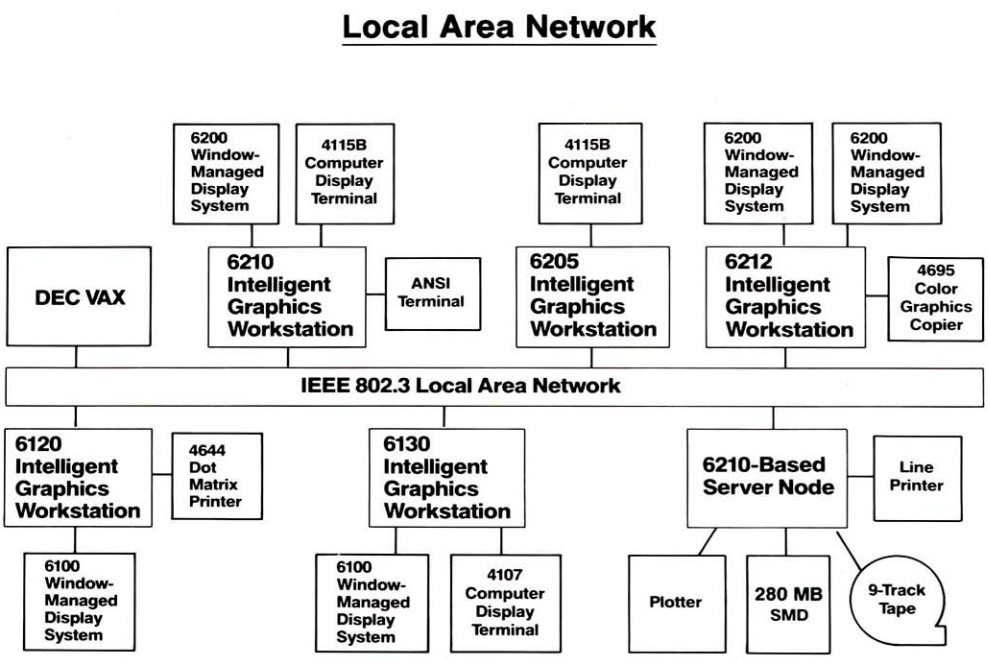
The 6000 Family of Intelligent Graphics Workstations have been developed to provide balanced performance for a wide range of applications. They are fully compatible and modular (for applications growth, present and future) and are designed with software support a priority (hardware and software designed in parallel).

Developing a workstation strategy is more than a matter of finding the right system—because no single configuration can meet the needs of a diverse group of scientists and engineers. Even within a single company or agency, disciplines as varied as electrical engineering, mechanical engineering, software engineering, documentation, data analysis, automated testing, and materials planning need to work together and share data; yet each group has its own specialized computing requirements. To meet those requirements, you look for a mix of display technologies, processing power and software tools; for systems that deliver the right price and performance on each desk; and for products that you can use with your existing equipment, not in place of it.

In the past, Tektronix has supported the needs of scientists and engineers by providing engineering instrumentation, computing controllers, software, and affordable, high-quality graphics terminals. Now, Tek expands its support by offering the 6000 Family—32-bit, high-performance multifunction workstations that deliver not just a single type of display or level of computing power, but a range of capabilities to handle the full spectrum of scientific and engineering applications. Also part of the 6000 Family are sophisticated software tools that play a key role in enhancing professionals' productivity. With the 6000 Family, Tek products now span from "dumb" terminals, entirely host dependent, through "smart" terminals with local graphics processing, to "intelligent" graphics workstations powerful enough for stand-alone applications.

A broad price/performance range is met by utilizing National Semiconductor's 32016 and 32032 processors. Both excel in the execution of high-level language programs. Most of the operating system and utility software is predominantly written in C and most application programs will also be high-level-language based.

To off-load the CPU and maintain peak throughput, the 6100 and 6200 Series workstation displays use dedicated display processors, and the 6200 Series workstations use an additional I/O processor.




*Local area networks play a large role in the evolution of the workstation environment. High speed communication channels allow expensive resources to be shared among many workstations without performance degradation.*

The 6000 Family of Intelligent Graphics Workstations takes a two-pronged approach to accommodate a broad range of design tasks. It includes six basic but configurable workstation models. Then, to enable these workstations to work together and to be integrated with already purchased equipment, it provides flexible interfacing, a common operating system derived from UNIX, a relational database management system and a Local Area Network, shown above. A distributed file system is also provided. In addition, the Tektronix operating system based on UNIX, includes an electronic mail utility that provides user-to-user communications. An optional, fully relational data base management system facilitates data sharing among workstations. The LAN also allows workstations to easily share the use of peripherals.

No single workstation architecture is appropriate for activities as varied as designing a product and preparing a bill of materials for that product. The level of parallelism and message-passing speeds required for intensive CAD applications would be prohibitively expensive in an application that does not demand such high performance. Conversely, a single-processor architecture, although well suited to moderate finite element modeling, drafting or analytical loads, simply could not meet the response-time requirements of computationally intensive tasks such as interactive circuit simulation or solids modeling. Consequently, the 6000 Family is made up of two product groups which are software compatible but are based on different system architectures.

An engineer can also upgrade from one product to another within a product series by adding software, memory and disk options. This can be a much more cost-effective option than having to purchase additional workstations when requirements increase. For instance, a mechanical engineer who is running both a finite-element-analysis program and doing interactive finite-element modeling may find that running the analysis program in the background is beginning to slow the system response time. With the configurability of the 6200 Series, the engineer can add another compute engine and more memory, placing the analysis code on a separate processor.

Along with the requirements for varying levels of processing power, engineering applications also differ in the resolution and interactivity needed in their display systems—from the modest amount needed for text processing to the high resolution required for applications such as solids modeling. The 6000 Family workstations acknowledge this range by providing compatibility with Tektronix 4010, 4100, and 4110 terminals, as well as DEC VT-102 emulation. In addition, integrated display systems have been developed specifically for the 6100 and 6200 Series workstations. These display systems provide a consistent window-managed user interface across the family. Both color and monochrome versions are available, with resolution ranging from 640 x 480 to 1024 x 768 and size varying from 13 inches to 19 inches. A microprogrammed display-list processor, optimized for the Graphical Kernel System, provides high performance for the 6200 Series bit-mapped display.

For flexibility, a single workstation can support multiple externally connected terminals, and the 6200 Series can handle multiple integrated display subsystems as well.

**Software**

To lower the cost of developing and transporting application programs, the 6000 Family uses an open architecture approach and supports a number of software standards. In addition, a UIMS (User Interface Management System) allows application programs to use sophisticated, consistent user-interface constructs.

Standardization begins with an operating system based on UNIX, which is becoming a de facto standard among 16-bit and now 32-bit systems. The 6000 Family implementation includes the major features of System V and Berkeley 4.2, with virtual memory and demand paging for the efficient execution of larger programs. In languages, the 6000 Family has high-performance compilers for FORTRAN 77, C, and PASCAL. Also supported is the proposed ANSI BASIC, which integrates graphics, program segmentation, file processing, and structured-programming concepts. A language translation sifter is available to assist conversion of Tektronix 4050-Series desktop computer BASIC programs to the 6000 Family workstations.

The 6100 and 6200 display systems support the GKS (Graphical Kernel System), a standard that brings the advantages of device-independent graphics to workstation applications while maintaining high performance. Also supported are Tektronix PLOT 10 Computer-Aided Drafting (TekniCAD), TCS, and IGL.

A large pool of existing application programs based on UNIX can be ported to the workstations. To further expand the possibilities for accessing existing software solutions, the 6130 Intelligent Graphics Workstation can add an optional co-processor that provides compatibility with the MS-DOS operating system.

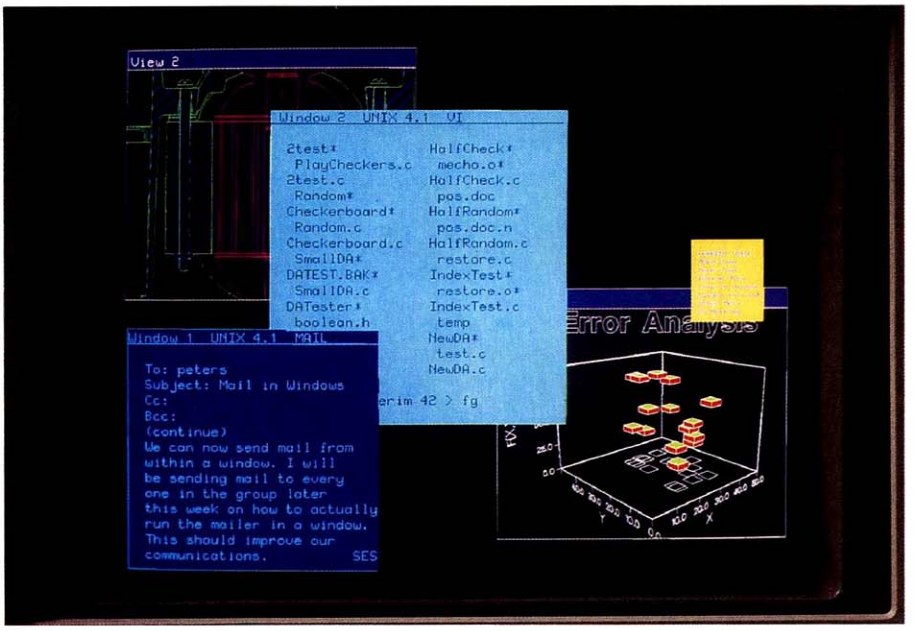
The User Interface Management System allows application programmers to build programs with a sophisticated and consistent user interface. The programs can also use the interface provided by the Casual User Interface, which is a complete operating environment. The user can move within the CUI to use the conventional operating system interface. Application programs developed or acquired may also be added to the CUI.

The CUI supports the tasks of system and network administration, making it easy to add network nodes or peripherals without detailed knowledge of the operating system.

The UIMS provides interactive user-interface language constructs that standardize the user interface across applications while reducing the amount of code to be written by the application developer. Using the UIMS, an applications programmer can interactively specify such user interface issues as the size, location, and color of menus and messages.

The 6000 Family expand their usefulness since they can be integrated with a variety of peripherals and other equipment.

For hard copy, these include color graphics copiers, dot matrix and line printers as well as large format printers/plotters. For auxiliary mass storage at the workstation or network level, 9-track tapes and high performance SMD disks are also supported.




*Window systems optimize a system's multitasking capabilities by dividing a display into several regions, each supporting a different process.*

The window management graphics make possible a highly interactive user interface highlighted by multiple windows. Each window is a "virtual terminal," in effect giving the user the ability to interact with several terminals at once and execute several programs simultaneously. Terminal emulation is also available, so that one window can be opened to a host computer while at the same time a workstation application program executes in another window. Both static and pop-up menus are used extensively. Commands can be entered with conventional command-line entry or via a mouse.

Computer graphics is a key element of any computer-aided activity because it is the most effective interface between humans and computers.

## Color Perception

The physiological fact behind color's continued success in displays is that the brain has two separate channels for processing visual information: one chromatic, the other achromatic. In many instances, data from both processing channels is used to interpret an image. An achromatic display deprives the operator of one entire visual data channel. Without this chromatic data flow, the brain's processing power is reduced, especially when interpreting complex visual information. The use of color substantially improves the readability of electronic instrument displays.

Color is particularly beneficial when viewing a complex display with high information density.

First, color can be used to organize information into logical groupings. High-priority items can be coded one color and low-priority items another.

Second, color can be used to locate information. This is especially useful when small but important items might be visually lost in a mass of other information.

Third, color can attract attention. Finding a single element in a complex array is easy when a color difference exists. A specific color can be associated with a particular class of events, such as red for warning or yellow for critical information. Color also allows a single instrument to function in different modes with a particular color unambiguously signaling the mode.

Fourth, color definitely has a high aesthetic appeal which reduces the monotony of prolonged display viewing. Although only subjective reports substantiate this aspect, color appears to enhance productivity by reducing boredom and fatigue.

The proper use of color can improve the functionality of an instrument in both the perceptual and cognitive domains. Further, color can enhance the discriminability between simultaneous events; their separation is easiest when color is used to distinguish them. Another perceptual aspect is the relative permanence of colors. Although the exact hue may change slightly as illumination or observer adaptation changes, red still remains red. This is not true of achromatic luminance (gray levels), which may appear substantially different under different lighting.

### Ergonomics of Color

Through technical improvements and cost reductions, color has now become a potentially powerful tool for improving the instrument/user interface. Yet, the misuse of color can make the interface more difficult instead of easier.

Color is a product of human perception, the result of the eye reacting to "visible" wavelengths of electromagnetic radiation. The optical and sensory mechanics of the eye give color its three basic qualities:

Hue, which identifies the color in relation to other colors in the spectrum, such as red, yellow, green, etc.

Saturation, which defines the "purity" of color. As spectral colors become less pure, they appear more gray or white.

Lightness, which refers to the relative strength of the light coming from the color, as perceived by the observer.

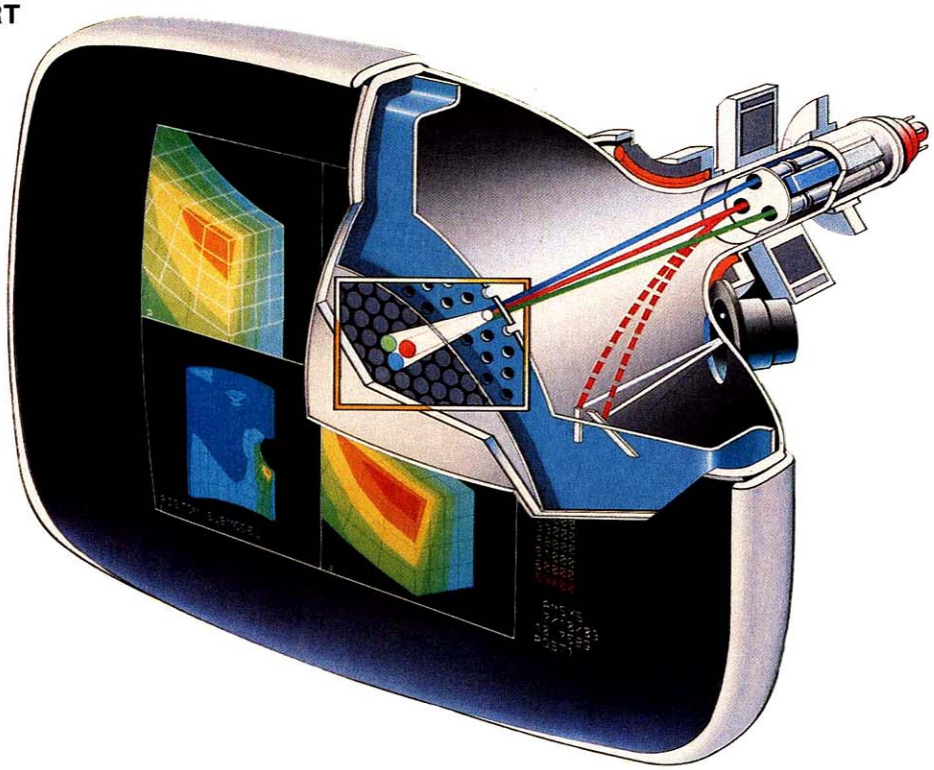
As the wavelengths of visible light change, the eye perceives a changing hue that produces the familiar spectral colors, ranging from deep red through yellow, green, and blue to purple. At any given wavelength, a "pure" color is produced that yields maximum saturation. Pure colors can be desaturated by increasing lightness until the color is "washed out."

Color distribution and saturation play an important part in color perception. Colors widely separated in the spectrum, such as red and green, are much easier to discriminate than neighboring colors. Also, "grayish" colors of low saturation become difficult to separate. On the other hand, highly saturated colors that are also widely separated in hue require the eye to refocus, which can be a source of fatigue. Another important consideration is that the eye's foveal region, which yields maximum visual resolution, is essentially "blind" to the color blue, making it a poor choice for presenting detailed information.

### Color Display Technology

The CRT is the most important factor in determining characteristics of a color display. Tektronix color display technology produces three basic types of CRTs: the shadow-mask CRT (page 21), the liquid-crystal (LC) CRT System (page 30), and the Direct View Storage Tube (page 32). The choice of CRT and display system is determined by the user's needs and application. For any particular color display application, the user is concerned with image quality and information handling capability relative to that application.

## Shadow Mask CRT



*The 4115B's patented AutoConvergence is accomplished by applying non-parallel indexing phosphers at precise angles and positions at the rear of the CRT shadow mask.*

The shadow-mask CRT is the most commonly used type of CRT for color displays all types. In fact, the shadow-mask CRT is the type used for home television and for studio television picture monitors. Usually, three electron guns are used to address three primary color phosphor dots or stripes. The dots are spaced close enough so they appear as one. Colors other than the three primary colors result from proportional mixtures of the individual dots. A shadow mask is used to make sure that each beam addresses only its assigned color dot. The beams from the red, green, and blue guns must pass through the mask openings at the proper angles to strike their corresponding phosphor dots.

The three beams are deflected together over the phosphor screen in a raster pattern.

One of the most important factors in the recent evolution of computer graphics has been the emergence of high resolution, low cost raster displays. We've overcome the problem of CRT flicker with 60 Hz noninterlaced monitors. Raster technology is pushing the limits of human perception.

In other systems (e.g., home television), an interlaced raster is used. An interlaced display scans every other line in the the first pass from top to bottom, then returns to the top and scans the intermediate lines in the next pass. A color image is drawn on the screen by the display system, which determines when each of the three electron guns receives current, and how much, and thereby how much of each color is produced at each point (pixel) on the screen.

When a shadow-mask CRT is used in graphics applications, a bit-map memory is used to store the image. The pixel information from the bit map is read out to the three electron guns in synchronism with the raster pattern of the beams. To produce an image on the CRT screen, the desired vectors and other shapes must first be converted into the proper pixels in the bit map using a scan conversion process. Algorithms are used to code the various shapes into several digital bits, representing the brightness desired at each pixel location on the screen.

Information in the bit map must be read out repeatedly to the CRT at a rate fast enough to avoid flicker. Therefore, the time required to change images on the screen is determined by how fast the scan conversion process can reload the bit map. The larger the bit map, the slower the reloading process; thus, raster images with a large number of pixels must trade off speed of interaction. As the number of pixels increases, so does the rate at which information is clocked out of the bit map. The deflection speed of the CRT beam and the bandwidth of the CRT video amplifier must increase accordingly. Deflection speed and video amplifier bandwidth ultimately limit the number of pixels possible.

### Color Purity and Convergence

Color purity generally refers to the uniformity that a color has over a large area of the display screen. Purity is a measure of whether or not the primary colors selected by the individual beams are spectrally pure. If some electrons meant for the red dot impinge upon the green dot, then the primary color is not pure. Purity is not really much of a problem in shadow-mask CRT displays. Each of the three beams should excite the entire phosphor dot when the beams pass through the shadow-mask holes properly.

High resolution displays introduced another new problem: *misconvergence*. When the display is not properly converged, a line written as yellow, for example, comes up with a red and green fringe on either side. Misconvergence which was simply annoying on the previous new generation of high resolution displays has become a source of potential misinformation on the new generation of high resolution displays. In fact, the convergence specification over the entire active area of the display becomes the effective resolution limit. That is, a 1000 line display is not useable as such unless the convergence specification insures no detectable misconvergence anywhere on the screen.

### AutoConvergence

The 4115B Computer Display Terminal contains a first-of-its-kind convergence feature that automatically corrects the natural drift occurring in the convergence of the color raster writing beams (shown above). Convergence is controlled to within 0.2 mm over the entire display area, resulting in sharper characters, lines, and colors. Technical skills are not required to maintain optimum convergence.

## Color Display Characteristics

Image quality and information handling capability are the two broad categories of characteristics that are important to users of color displays. Image quality includes optical characteristics like resolution, edge sharpness, brightness, contrast and color quality. Environmental "noise" can cause undesirable optical characteristics of displays, such as flicker, jaggies, and moire patterns. Information handling capability includes characteristics like display size, number of vectors or pixels, and number of colors.

### Resolution

The quality of the image is strongly affected by the resolution of the display system. However, the term resolution is often used synonymously with the number of scan lines (addressability) in discussions of raster displays. Resolution refers to the display's ability to resolve or separate two closely spaced points, lines, or spatial frequencies. Resolution is the essential characteristic that determines image sharpness. The resolution of a display comprises a combination of elements including spot size, spot profile, dot spacing, number of scan lines and bandwidth. Addressability, on the other hand, refers to the display's ability to position lines or pixels anywhere on the screen. A display may have addressability that exceeds its resolution capability and so will not affect the resolution of the display. However, if the addressability is not high enough, it will affect the resolution of the display in complex images.

### Color Quality Characteristics

Quality of color includes brightness, contrast, purity, and convergence.

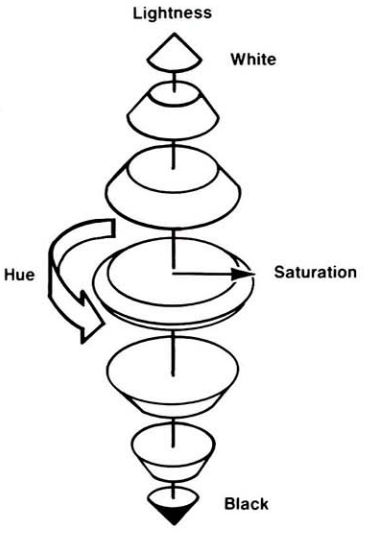
Both the DVST with CWT and shadow-mask types of color displays reflect and scatter about the same amount of room light, so display contrast is determined by trace brightness. Display contrast can be improved by placing a filter in front of the display screen that will attenuate the emitted light less than the reflected light, which must make a double pass through the filter. Selective filters are also used to absorb room light while transmitting the emitted light from the display. Antiglare screens, which have either a special coating on the front surface or a matte finish to prevent specular reflections, are also used to improve display contrast.

## Information Handling Characteristics

### Size

The ultimate size of color displays using DVSTs and shadow-mask CRTs is about 636 mm (25 inches) diagonally. The DVST can also be made quite small (152 mm or 6 inches) and still provide a large number of vectors because the spot size can be scaled down accordingly. The number of vectors in the color refresh mode is not limited by the resolution, but by the deflection speed required to write the vectors at a flicker-free rate. To display a large number of vectors, the deflection system must have a very high bandwidth, usually at the expense of power. However, the DVST avoids the need for high power with large numbers of stored vectors, though it faces the same trade-off for the refreshed color vectors.

## Color Specification




*The double-ended cone can be used to express colors in terms of hue, lightness, and saturation. Hue is expressed in degrees from 0 to 360, lightness from 0 to 100%, and saturation from 0 to 100%.*

### Number of Colors

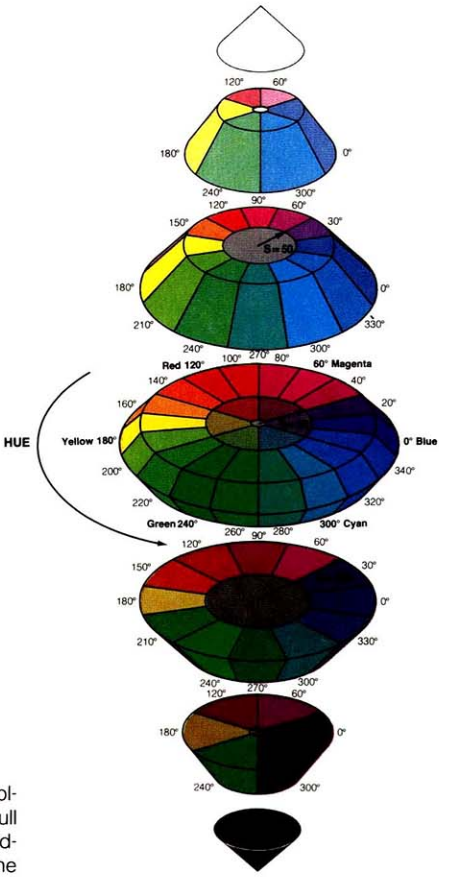
The DVST with CWT has a maximum of three colors. Only the shadow-mask CRT offers a full range of colors. The color capabilities of a shadow-mask CRT are usually determined by the choice of phosphors for the three primary colors.

The DVST with CWT is very useful where complex images are to be displayed and color is needed only to highlight areas of the display. The shadow-mask raster display is by far the most prevalent type of color display in use today.

An attractive feature of a color terminal is its ability to display images in the desired colors. But how does one go about selecting a specific color and describing it to a terminal in meaningful, precise terms? Interactively, the user specifies a color and the terminal displays it. The user evaluates the displayed color and corrects it if necessary. To be effective and expedient, the method of describing colors must ease this interactivity.

There are many theories and models for specifying colors. Colors for Tektronix terminals are specified using the double-ended cone shown above. Colors are selected by specifying hue, lightness, and saturation (HLS). These attributes relate to how colors are perceived. Hue is the characteristic associated with a color name such as red, yellow, or green. Lightness is the characteristic that allows the color to be ranked on a scale from dark to light. Saturation is the extent to which the color differs from a gray of the same lightness. For example, fire-engine red is highly saturated.

Lightness variations are represented along the vertical axis, with black at 0 percent at the bottom apex and white at the top at 100 percent. On a plane that intersects the cone perpendicularly to the vertical axis, all colors are of equal lightness. Variations in saturation are represented by a radial distance from the lightness axis. Hue is represented as an angular displacement around a circle intersecting the cone.




*Tek Color Standard is one implementation of the double-ended cone concept. It is relatively easy to specify a desired color in terms of hue, lightness, and saturation using such a standard.*

Stated quantitatively, hue is a variation of color advanced by degrees represented as an angle from 0° to 360° from a reference where 0° is blue.

Saturation is expressed as a percentage of the distance to the surface of the cone ranging from 0%, maximum white at that lightness level, to 100%, which is fully saturated.

The Tektronix HLS color standard for a graphics terminal with a 64-color palette illustrates the implementation of the double-ended cone. The continuous and theoretically infinite cone has been partitioned into 64 regions of color. Figure 6 can be used to illustrate the concept of specifying color. For example, fire-engine red can be specified as: hue is red (120°), lightness is 50%, and saturation is full (100%). This color would be specified as 120, 50, 100.

The HLS method of specifying color provides terminology and a conceptual framework for working with color. Because the cone and input numbers are easily learned and remembered, users are able to select a color from the color cone and display it close to the desired color on the first try. After evaluating the color they can easily change hue, lightness, and saturation as needed. Yet, increases in the numbers of obtainable colors on a display will demand alternative means of color specification. The HLS system has 3.6 million color addresses (360 x 100 x 100) while the 4115B has 16 million color addresses (eight bits per gun). Ongoing research at Tektronix seeks to enhance the interface to color beyond today's standard set by Tektronix.

**Depth and Breadth of Display Capabilities . . .**

The 4100 Series (shown above) is a family of fully-compatible computer display terminals —answering a range of analysis, presentation and design needs. The new desktop family eases system integration and expansion whenever and to whatever degree required.

# Up to 8 Graphic Planes and 256 Colors

*The 4115B's user-selectable coordinate space is a staggering four billion x four billion points: enough to describe IC's in 0.001 μm increments. You can work with as many as eight graphics planes to provide 256 colors. 50,000 vectors/second redraw speed.*

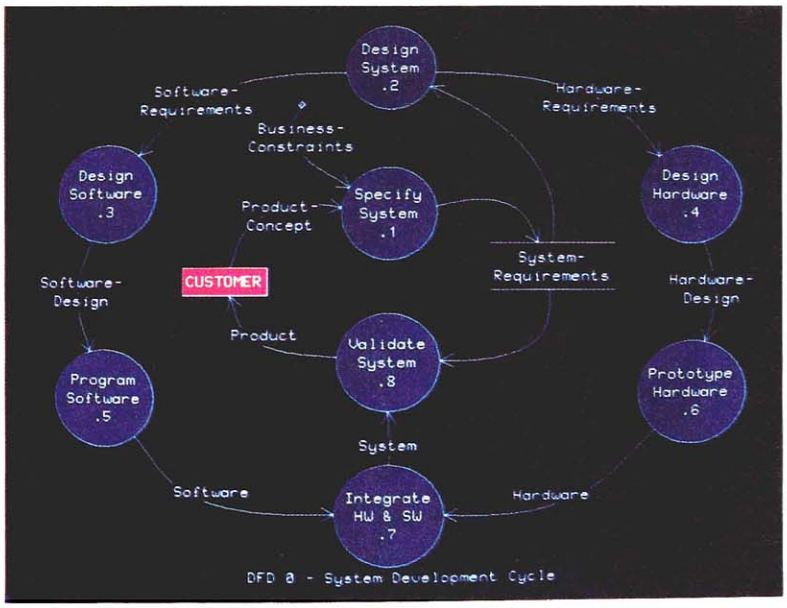
*The 4115F58 3D wireframe enhancement and 4115P51 feature enhancements are new for the 4115B Computer Display Terminal, shown here in a modular configuration. The 4115F58 allows local 3D matrix transformations and parallel and perspective projections, in addition to other features. The enhancement consists of an 80286/80287 processor set, firmware and micro-code changes to the 4115B, and a new keyboard with numeric keypad and ports to support a joystick and mouse simultaneously. The 4115P51 feature enhancement delivers pop-up menus, multiple scrolling dialog areas, segment subroutines, segment editing and circular arcs.*

# Microprocessor Development Tools for the Complete Design Environment

```
#include <stdio.h>
#define MAXOP 20            /* max size of operand, operator */
#define NUMBER '0'          /* signal that number found */
#define TOOBIG '9'          /* singal that string is too big */
#define RUBOUT '\177'       /* ascii rubout character */

main() /* desk calculator */
{
   int type;
   int op1i, op2i = 0;
   char s[MAXOP];
   double op2, atof(), pop(), push();

   while ((type = getop(s, MAXOP)) != EOF)
      switch (type) {

      case NUMBER:
         push(atof(s));
         break;
      case '+':
         push(pop() + pop());
         break;
      case '*':
         push(pop() * pop());
         break;
      case '-':
--More--(33%)[Hit space to continue, Rubout to abort]_

ColorKey+ - top level

analysis F1 | design F2 | edit F3 | code F4 | debug F5 | files F6 | sys.op F7
```

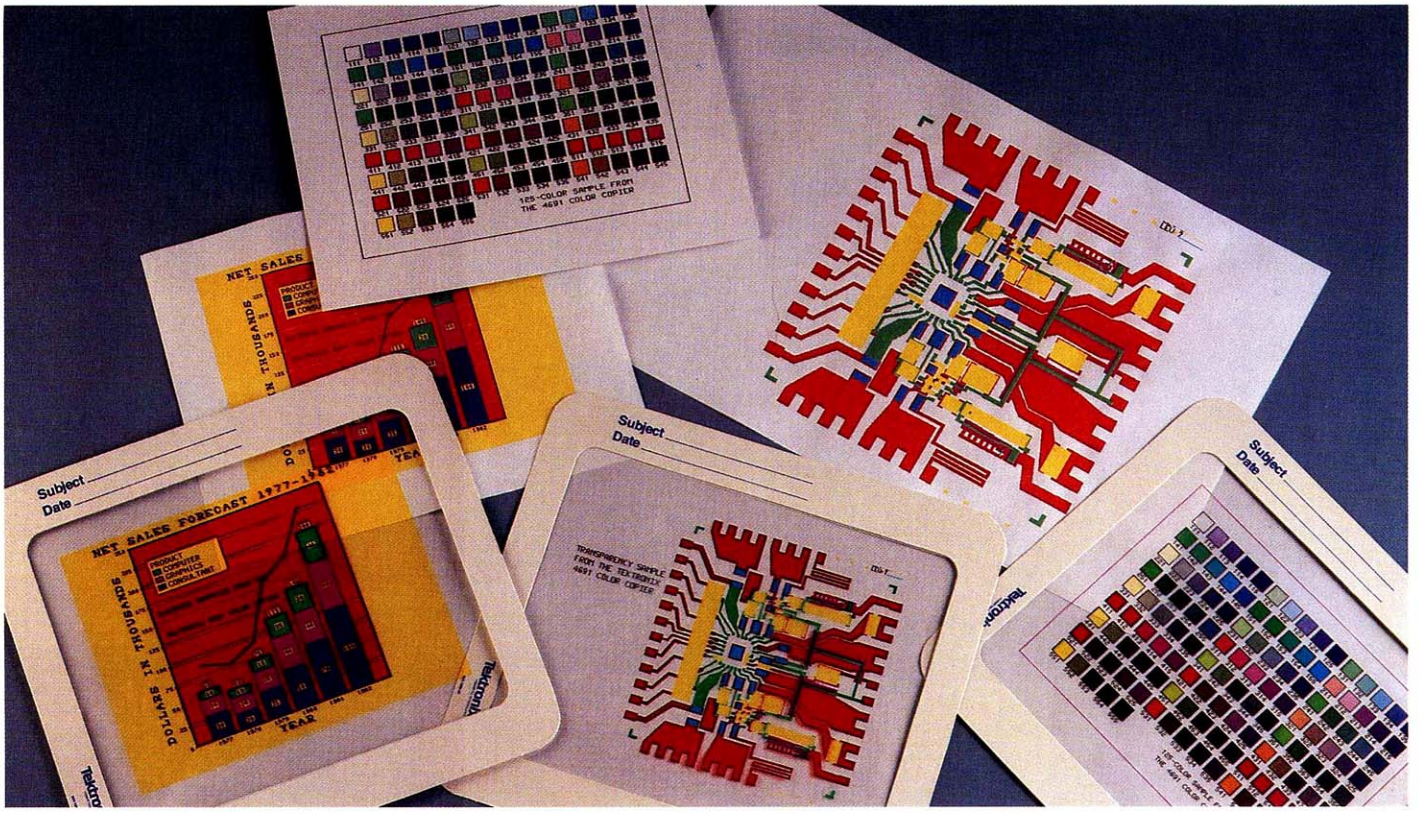
*ColorKey+ utilizes the color graphics capabilities of the Tek 4105 color terminal to provide a uniquely simple interface to the powerful TNIX operating system. With single keystrokes you can access Tek's powerful microcomputer development tools.*

*The use of color greatly enhances Tek's microprocessor development tools. Shown is LDE, screen oriented editor, with text marked in red for pasting, deletion, or syntax checking. An invaluable tool for high level language software development.*




*Tektronix' color graphic products are a key component of Tek's Microcomputer Development System (see page 90). These systems support the principal activities of the development cycle for microprocessor-based systems. The diagram above, displayed on Tektronix 4115B Computer Display Terminal, was created with Tektronix' Structured Analysis (SA) Tools to show this system development cycle. SA Tools, part of Tek's Microcomputer Development System, is used in the first phase of the system development cycle to specify requirements.*

# Select the Colors, Resolution, Sizes and Media You Need




*The 4691, 4692 and 4695 Color Graphics Copiers offer high-quality transparency and plain paper copies.*

## COLOR HARDCOPY TECHNOLOGY

### Information Sharing

The need to share information, coupled with the growth of the use of color to clarify and define information, has resulted in expanded applications for color graphics copiers.

### Color Graphics Copiers

Tektronix Color Graphics Copiers use on demand ink-jet technology to produce eight-color copies from computer graphics displays.

Ink-jet printers create graphics with fine dots of colored ink. The ink is simply accelerated toward the medium in fine droplets. Ink-on-demand generates tiny individual ink droplets for a particular graphics point when required.

The ink-on-demand technology has several advantages over a continuous ink circulation technology. A continuous ink circulation system requires frequent cleanup, and air bubbles and other contaminants introduced during recirculation can clog nozzles and even alter the chemical make-up of the ink. This can result in reduced color quality and persistence.

Ink-on-demand is clean, low maintenance and offers finer resolution than impact methods with better saturated colors and finer detail. It offers better area-fill capabilities than pen plotters and produces faster copies as well. This is particulary true when images are complex combinations of lines and filled areas, with text as well as graphics as part of the copy.

### A Family of Copiers

The 4690 Family of Color Graphics Copiers consists of the 4695 high quality, personal color copier; the new 4692 very high quality A-size color copier and the 4691 very high quality A and B size color copier.

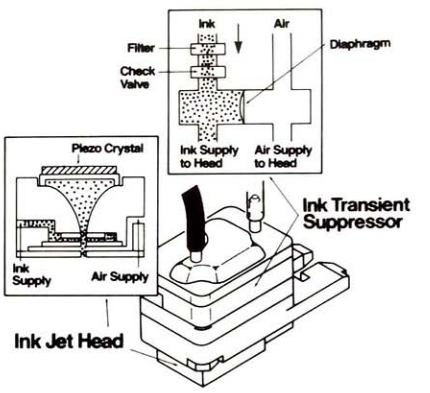
The 4695 provides unprecedented image quality in its price range.

Where higher speeds, automatic media handling and standard A/A4 size output are required, the 4692 will be the preferred solution. With multiplexing, the 4692 spreads the cost per user.

For complex images such as geometric models or maps, the B-size copies of the 4691 provide the detail needed.

Used with the 4510 Color Graphics Rasterizer, both the 4692 and 4691 Copiers are effective system resources for color hardcopy, providing unmatched paper and transparency output regardless of the terminal.

All three copiers offer superior image quality and outstanding price for performance.



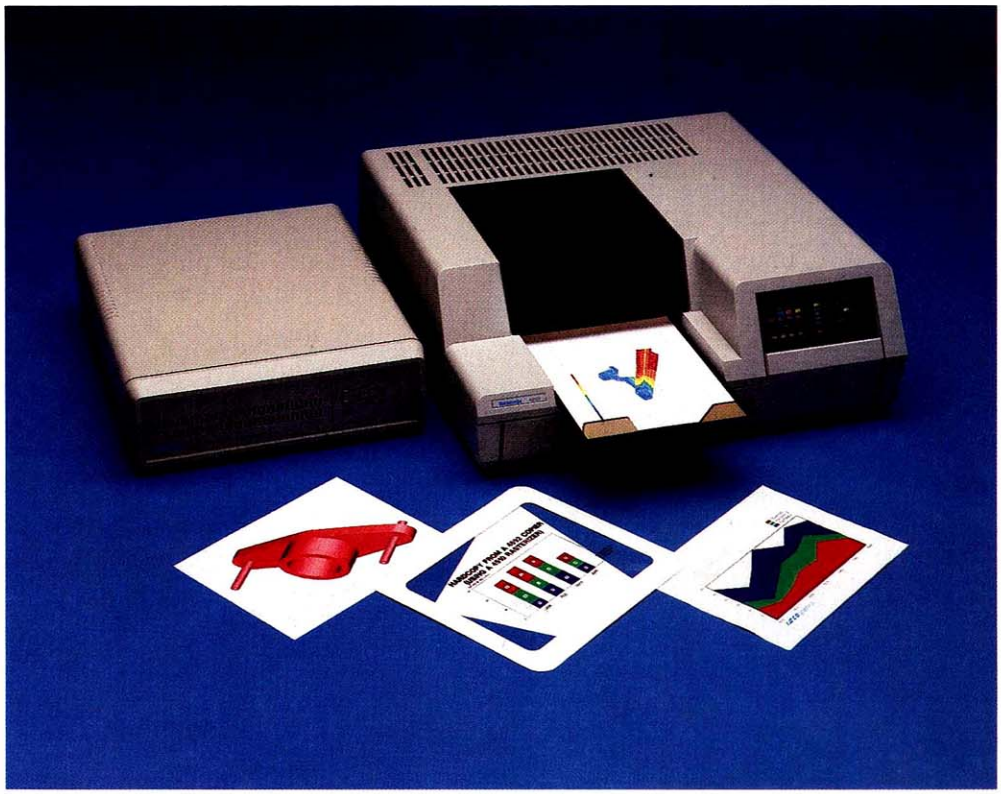

*The 4692 incorporates new Tektronix design development, the Ink Transient Suppressor, to increase ink-jet reliability. The Ink Transient Suppressor uses a five-micron mesh filter to trap bubbles and particles that may have worked their way into the ink system. A one-way valve prevents ink from flowing away from the ink jet heads, and a flexible diaphragm, exposed to air on one side and ink on the other, suppresses shock when the copier is jolted and moved. These features eliminate bubbles and head clogs.*

The newest member in the spectrum of Tektronix color copiers, the 4692 Color Graphics Copier, offers superior color output on A-size (8½ in x 11 in) or A4-size (297 mm x 210 mm) paper or transparencies. The 4692 Copier delivers crisp graphics in up to 216 colors and halftones (256 when used with the 4510 Rasterizer).

Specially matched paper, transparency film and ink result in 4692 copies of the brightest, most highly saturated colors available outside of color photography. Business graphics, scientific data, maps or mechanical drawings may be copied from the terminal screen in rich, true colors.

For copying finely detailed graphics images, you will find the new hardware rasterizer from Tektronix an invaluable companion to a Tektronix 4691 or 4692 Color Graphics Copier. Connecting the 4510 Color Graphics Rasterizer between a host or terminal and a 4691 or 4692 Copier, you can copy a drawing, map, or graph at the full resolution of the copier in 256 solid and halftoned colors out of a palette of over 132,000.

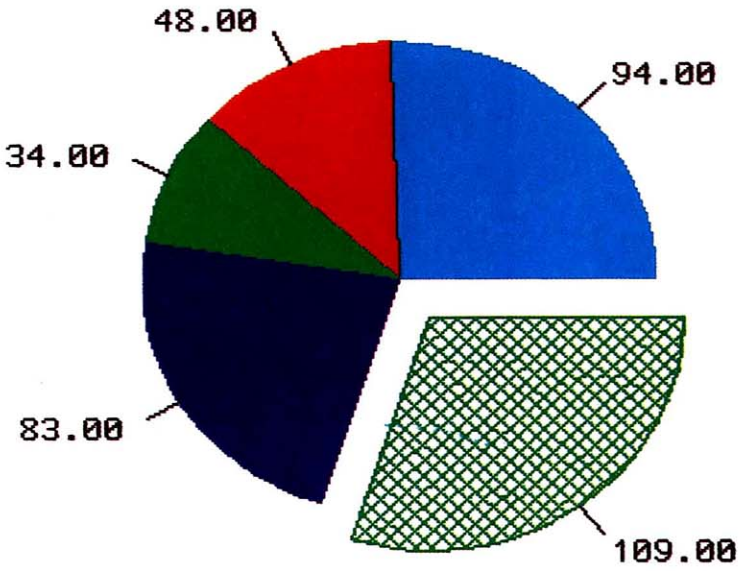
The 4510 Rasterizer eliminates the need for a host-intensive software rasterizer and speeds the copy time. All of the rasterization and spooling tasks are performed by the 4510 Rasterizer. It accepts high level graphics commands across the RS-232 interface, converts them into raster format dots, and transmits them to the color copier. Host processor time is minimal; communications time is short; and you have your copy quickly for meetings, for reports or for your own analysis.



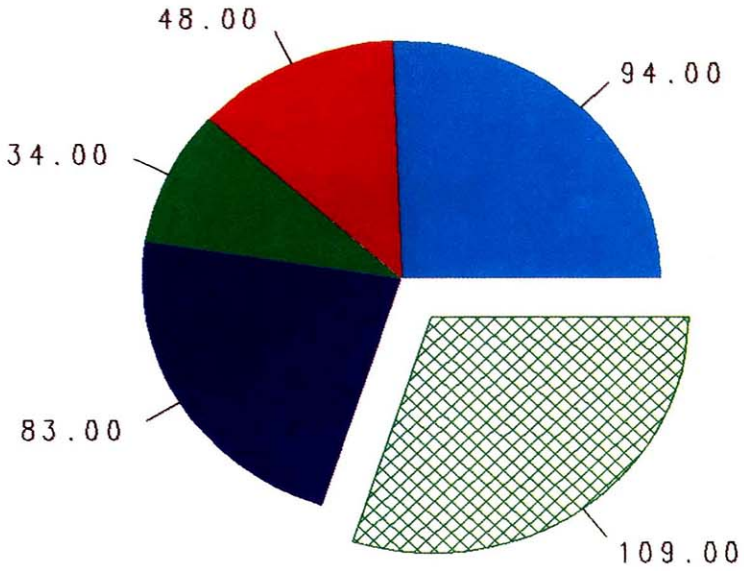
*The NEW 4692 Color Graphics Copier and 4510 Color Graphics Rasterizer—see pages 66-67.*

Characters, which may be fuzzy on a terminal screen, become crisp and legible using the 4510 Rasterizer. "Stairstepped" raster lines become virtually smooth. Even E-size (34 x 44 in) engineering drawings can be legibly printed on B-size paper using the 4510 Rasterizer and the 4691 Copier's ability to print 3.8 million points of color information.

Color copies produced on the 4692 are shown below. The density and vividness of the actual copy is greater than represented here, due to limitations in the printing process. The image on the left is copied from a 4107 Terminal screen (non-rasterized). The image on the right shows the smoothing provided by the 4510 Color Graphics Rasterizer.




*Nonrasterized screen copy from 4107*



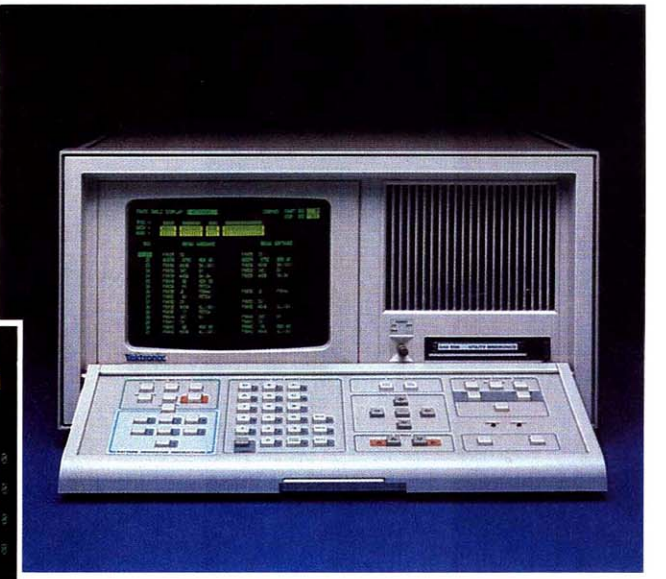

*Rasterized 4692 output from the 4510*

# Improved Accuracy and Speed In Logic Analysis

ACTUAL SIZE

## Logic Analysis

These complex, high-density displays are more readily comprehended when viewed in color. The DAS 9129 Digital Analysis System display is coded in red, green and yellow. The use of these phosphors (instead of the usual red, green and blue) minimizes the effects of misconvergence (each character uses only one phosphor) while allowing the user to concentrate on high priority information displayed in yellow, or error messages displayed in red, as opposed to the quieter background shown in green.



*The large, easy-to-read color display of microprocessor mnemonics saves time for engineers debugging system operation.*

*Red cursors allow the DAS 9100 user to easily identify short time intervals, down to 1.5 ns!*

# Color Monitor's Versatility Provides High Performance in a Wide Variety of Applications

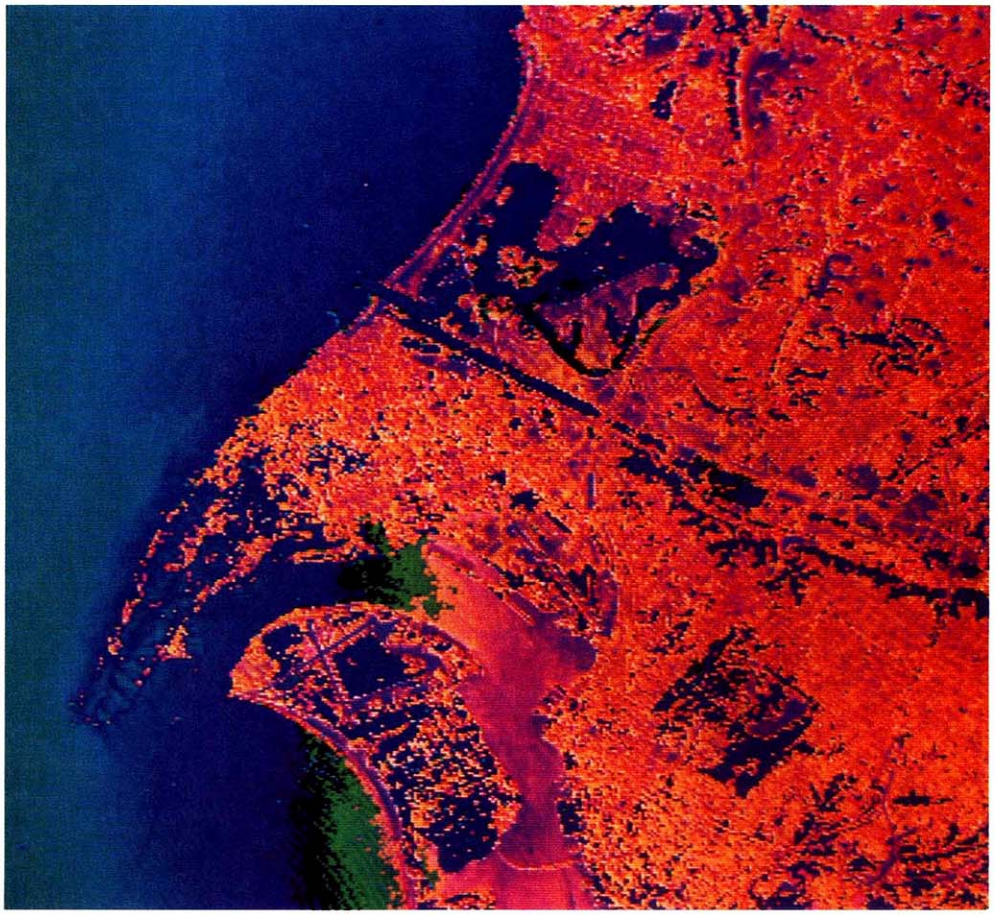
**Pure White**
One of the major concerns in a television program production is that the color temperature of "white" be set accurately and maintained throughout the production. Changes in white balance cause unnatural colors to appear.

To reduce the need for white-balanced adjustment, the 690SR employs beam-current feedback to offset changes in the CRT bias characteristics. Carefully designed video circuits ensure that tracking errors (relative changes in video gain between red, blue, and green channels) are held to less than two percent. The 690SR reduces the white-balance adjustments to the level of routine maintenance. Such stability ensures that if a problem is visible during critical viewing of a television production, it is not likely to be in the picture monitor.

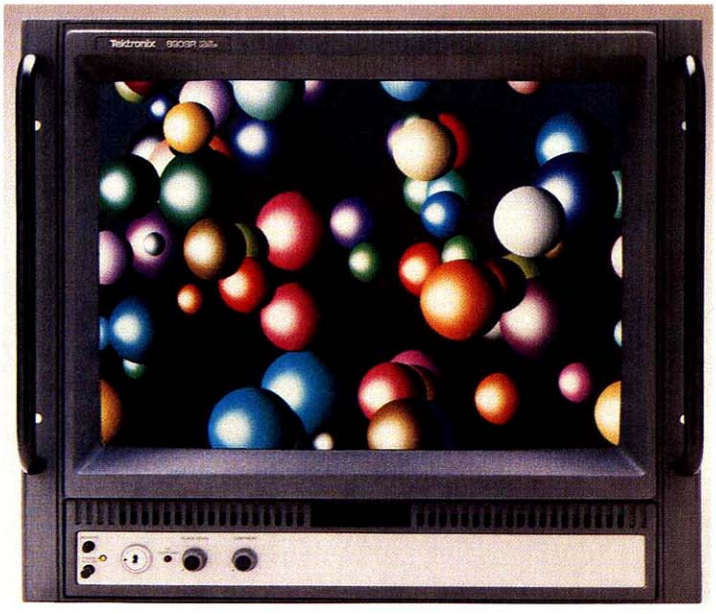
**Best Resolution and Light Output**
The 690SR standard CRT is a fine-screen 0.31 mm pitch, high resolution, delta-gun, dot-matrix type. The phosphor is Matsushita's "standard" set with medium-short persistence. This tube has a polished faceplate and is suitable for applications where light output and resolution are primary considerations, incuding most nontelevision and some standard television requirements.

**Medium Resolution, Controlled Colorimetry**
The Option 25 CRT has 0.43 mm pitch, a medium-short persistence, and a polished faceplate. There are two advantages of the medium-resolution screens: better uniformity of light output over the area of the screen, and controlled phosphor colorimetry. (As the size of the phosphor dot decreases, the grain size of the phosphor becomes significant, and tolerances on the colorimetry of emitted light cannot be as closely controlled.)

The Option 25 CRT is particularly suited to television applications using the NTSC system and to other applications which have similar colorimetric requirements. Primary application is in United States television environments where tight colorimetry specifications and uniformity of light output over the entire screen are a primary consideration and resolution requirements are not high.



*False-color-processed image of San Diego, California vicinity benefits from precision characteristics of the 690SR Color Display.*



*The photograph of a 690SR screen shows the image created by an experimental system which uses dither to decrease edge effects and contouring allowing minimization of the size of the image memory.* *See page 186.*

## Liquid-Crystal Color Display (The Color Shutter)

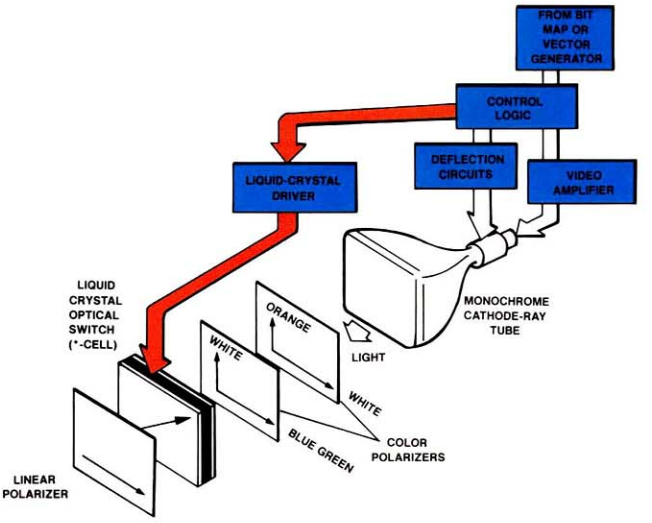



*Figure 2. Control logic drives a liquid-crystal switch that, by twisting light coming through two filters, lets the linear polarizer filter out emissions from a monochrome CRT. The eye integrates them into orange, blue-green, or an in-between yellow where the traces overlap, as shown above.*

A method of producing color displays without shadow masks, color-dot phosphors, or any of the other usual techniques has been developed by Tektronix. Based on a combination of liquid-crystal and cathode-ray tube technologies, this LC/CRT system (shown in Figure 2) combines a black and white or "monochrome" CRT and a liquid-crystal "color shutter" to produce a very-high-resolution, field-sequential color display. Functioning as a color shutter, this very fast switching device fits in front of the CRT face, thus making it practical to build high-resolution color displays into oscilloscopes and other display instruments. Because no shadow mask or patterned phosphors are used, the resolution can be as high as any monochrome CRT. This is a particular advantage in small display sizes where high-resolution color has not been practical before.

The "monochrome" CRT employed has a simple phosphor with two separate emission peaks that are orange and blue-green. The phosphor does not require any special process steps. However, the true "state-of-the-art" advance represented by the color shutter is the liquid-crystal shutter itself, which provides a three-color display (orange, blue-green, and neutral) of excellent crispness, detail, and color purity. On the 5116 color oscilloscope, the LC shutter is basically a sandwich consisting of a color polarizer, a variable-retardation liquid-crystal cell, and a linear polarizer. The LC shutter consists of two glass plates coated with indium tin oxide for the transparent conductor, a thin layer of silicon dioxide for an insulator, and a special "alignment" layer that causes the director (essentially the major axis of the liquid crystal) to tilt in the same direction on both surfaces.

### Field-Sequential System

Previous efforts to produce a field-sequential system have suffered from the lack of a suitably fast color shutter. Earlier attempts at fabricating LC color shutters have used simple twisted nematic (liquid crystal) devices or dual-frequency nematic devices. The simple LC devices generally have relaxation times (essentially the time to switch from one polarization state to another) that are much longer than several milliseconds and are not suitable for fast switching applications. Flicker-free operation of a sequential two-primary-color display requires field rates of 120 Hz, for example, which in turn requires LC shutters capable of millisecond transition times for both the on and off states. Dual-frequency devices can have sufficiently fast response but require the use of drivers that must deliver a high-frequency signal into a large capacitive load.

Employing a field-sequential system with displays having cells switched at a single frequency overcomes the need for high-voltage switching, a drawback of the dual-frequency cell approach. Typical dual-frequency cells are turned on with a low-frequency burst and turned off with a high-frequency signal, while the variable-retardation cell's elements are controlled by a single frequency. As a result the driving waveforms are simpler, and the driver's power requirements are less.

In any one field the information written on the screen appears only in the color selected by the LC shutter. The field-sequential system can provide all possible mixtures of the two primary colors contained in the phosphor. Each color or information field is displayed at a 60-Hz repetition rate.

### The Pi Cell

The variable-retardation cell (called a pi cell) is sandwiched between a set of red and green color polarizers and a linear polarizer at the output, and its axis is tilted 45 degrees with respect to the polarizers. The color polarizer orthogonally polarizes the orange and blue-green components of the CRT's emission, and the pi cell is used to sequentially rotate the polarized orange and blue-green information into the transmission axis of the linear polarizer. Rotation of the orange and blue-green information is performed in synchronization with the fields of the sequentially addressed CRT. Alternate fields, viewed through different colored polarizing filters, are integrated by the eye to give color images. By varying the Z-axis modulation, the full range of colors that lie along the line connecting the orange and blue-green peaks of the phosphor's emission spectrum on the chromaticity diagram can be achieved.

The pi cell derives its name from the pi-radian amount of twist it assumes in its quiescent or undriven state. Its features are achieved by speeding the relaxation time of an already fast untwisted birefringent variable-retardation cell, whose liquid-crystal elements are homogeneously aligned.

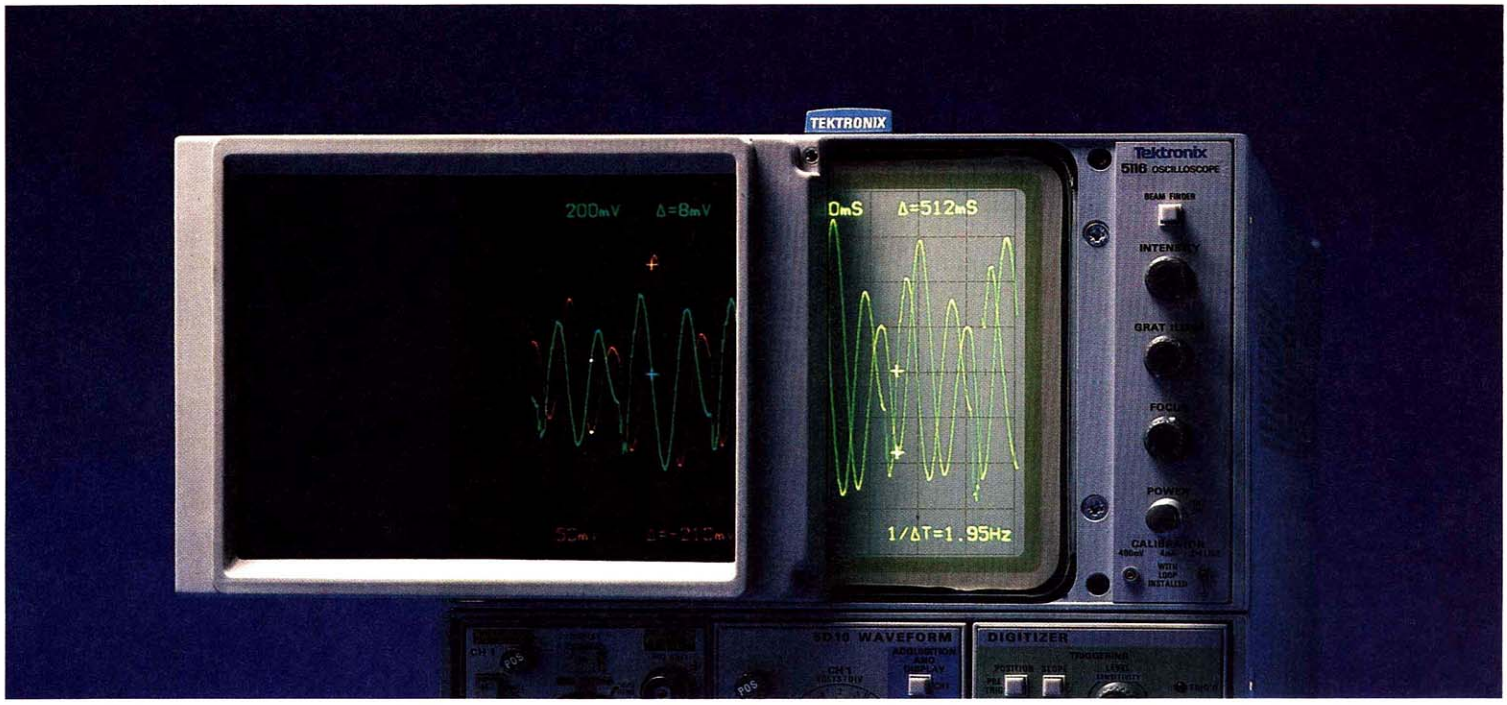
It is advantageous to keep the cell as thin as possible, since this results in a large angle of view, but narrowing the cell too much prevents achievement of the full half-wave retardation that is required. For LC shutters, such as used in our 5116 Oscilloscope, there is no perceptible color shift over the normal viewing angle.

### High Resolution, High Contrast

Among the LC/CRT system's advantages are high resolution over a wider range of display sizes, good contrast in high ambient light, and ruggedness, due to the absence of special shadow-mask and phosphor arrangements or complex electron guns. The LC color shutter can be used in either vector or raster displays.

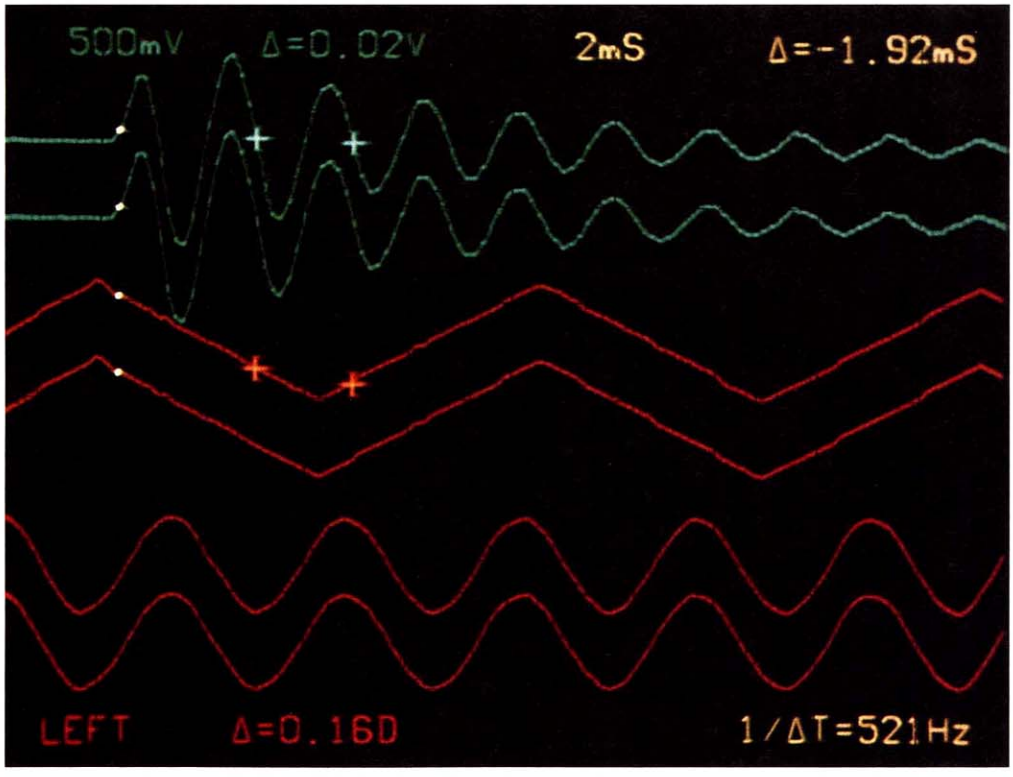
The combination of the color shutter and either a diffusing or an antireflection coated front surface can yield contrast ratios of better than 20:1 in the high ambient lighting normally found in today's offices. Since all screen writing is accomplished by a single electron beam, rather than by three beams as in a shadow-mask display, the LC shutter does not have misconvergence problems. This enhances resolution and produces a very readable display of text and complex graphics.

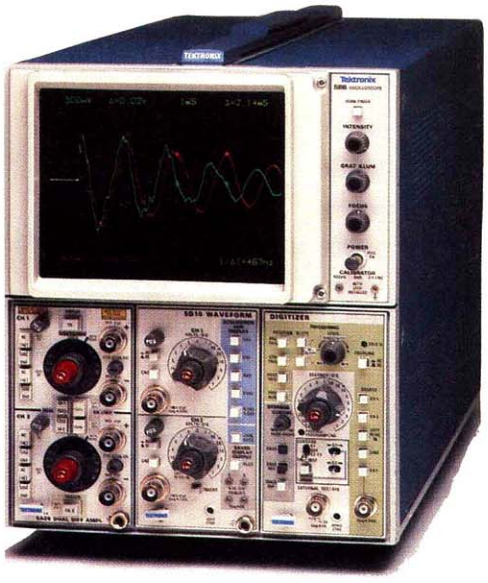
# Low-Cost, High-Resolution, Easily Discernible Multichannel Displays




*The 5116 Color Oscilloscope with 5D10 Waveform Digitizer, and the 5A26 Dual Differential Amplifier. See page 278.*

ACTUAL SIZE



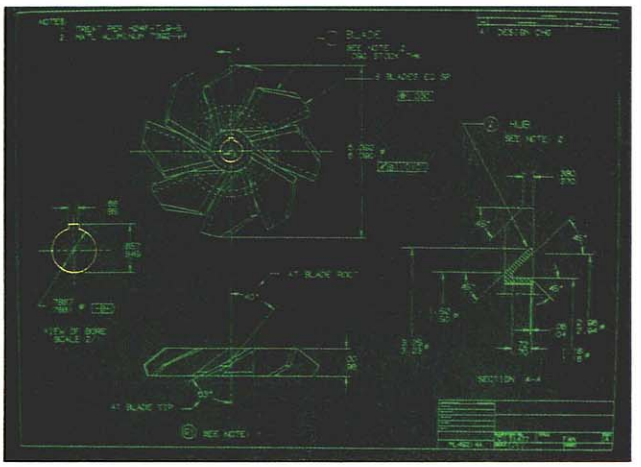
*This multichannel application uses a 5000-Series amplifier in the left compartment of the 5116 Oscilloscope to precondition the signal. Here a stored reference trace is compared with a later signal acquisition.*

## High-Resolution Monochrome Raster Display

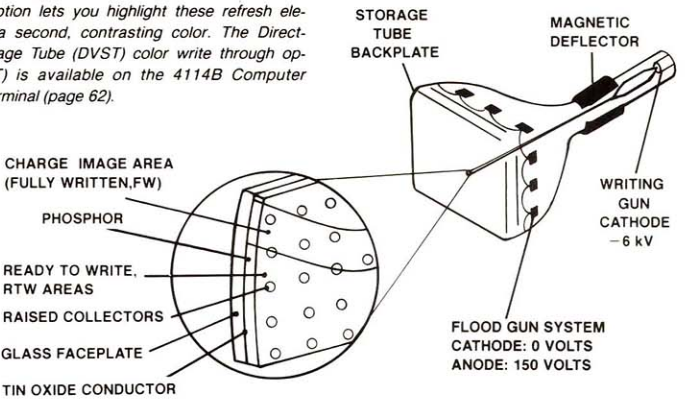
Key features of the GMA201 monochrome display include 1536 vertical by 2048 horizontal addressable pixels, digitally-adjusted focus, astigmatism correction, contrast enhancement panel and a crisp, well-focused beam at all points on the screen. A patented low-capacitance gun structure was developed to address the requirements for small uniform spot size, rugged construction and low power dissipation.

The GMA201 is well-suited to system builders in the fields of gray-scale imaging, CAD/CAM, computer-aided publishing, document retrieval, and related technical applications that require extremely high performance.

## Direct-View Storage Tube



*Frequently used symbols, as in this mechanical engineering diagram, can be recalled as needed, scaled, rotated and dragged into place. The Color Enhanced Refresh option lets you highlight these refresh elements in a second, contrasting color. The Direct-View Storage Tube (DVST) color write through option (CWT) is available on the 4114B Computer Display Terminal (page 62).*




The DVST consists of a writing gun that operates at a large negative potential with respect to the target, an array of low-energy flood guns, and a special phosphor target. The phosphor is separated from a transparent conductor by an insulating layer with an array of conductive dots. The phosphor is a composite mixture of two phosphors—the normal green for storage and a red phosphor with a dead layer surrounding it.

When the DVST is set to the storage mode, green vectors are stored on the screen (vector storage). The flood guns maintain the image on the display surface, so there is no need to continually redraw the image. There is no flicker, no matter how many vectors are drawn.

A separate local memory allows objects to be created and repeatedly retraced to produce a nonstored image on the screen (refresh mode). The nonstored image is retraced fast enough so that the viewer perceives a constant image.

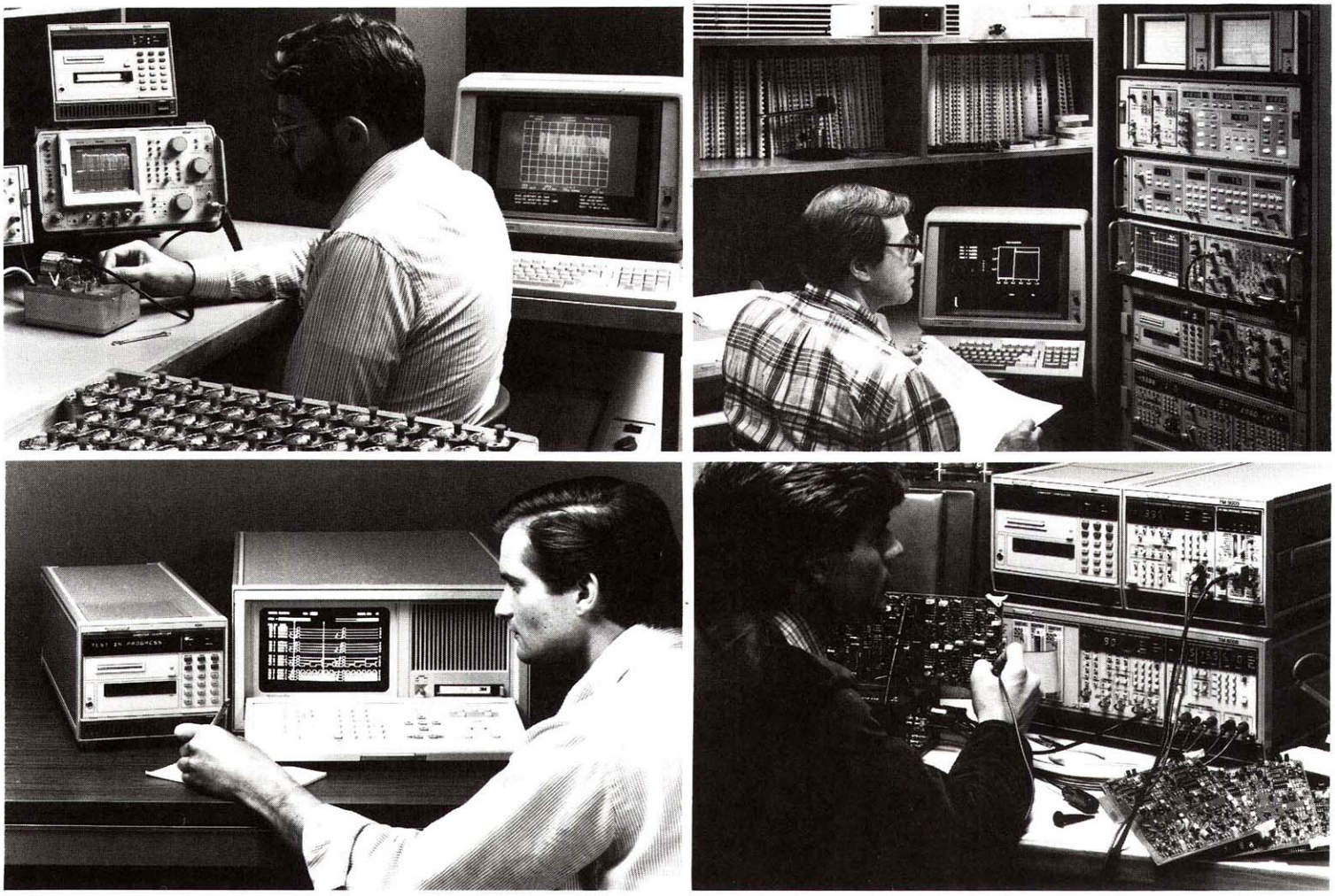
This feature allows images to be moved around the screen before storing or to be selectively erased without having to redraw the entire picture. Since the memory is essentially independent of the stored image circuitry, both stored and refreshed information can be displayed simultaneously.

It is not always easy to distinguish between refreshed and stored images on the screen of a DVST without CWT. Both images are displayed in a similar shade of green. Generally, the operator adjusts the writing beam intensity so that refreshed images appear dimmer than stored images. This method, however, sacrifices some brightness to gain differentiation.

With CWT, images of another color can be added to the display. When the write beam is operated with reduced current to prevent storage, a yellowish-orange spot is produced on the screen. This nonstored spot can then be deflected in a refresh vector mode (color refresh).

Color refresh not only increases the perceived brightness of images, but also introduces a color contrast between those parts of a picture displayed in refresh mode and those displayed in storage mode. The operator determines at a glance which segments in a displayed picture can be dynamically modified.

# Tektronix Means . . . Measurement Capability, GPIB Compatibility



As measurement needs grew in number and complexity over the past few decades, people began to realize that traditional design and test procedures were becoming inadequate. When the inadequacies became intolerable, special interfaces were designed and various instruments were connected to controllers to form specialized test systems. From these beginnings, some major benefits of automated test and measurement were quickly realized:

- Test and measurement labor costs were reduced.
- Human error decreased through precise and repeatable automation of measurements.
- Skilled people were released from mundane or repetitive procedures to pursue more creative research and design activities.
- Sophisticated analysis techniques could routinely be applied to provide greater insight into devices and processes.

But, for all their benefits, automated test and measurement systems still had some significant problems. Mostly, these stemmed from each system being unique, custom built. The automation need had to be severe to justify custom design costs. Systems and data formats were not generally compatible with each other. And changing the system or adding instruments meant another custom design effort.

Test and measurement automation was still too fragmented and costly for general use, even though the benefits were generally needed. A standard interfacing system providing across-the-board compatibility for a variety of instrumentation and instrument controllers seemed to be the solution.

## The First Step Toward Compatibility

In 1975, the first major step toward general compatibility in electronic instrumentation for systems use was taken. This step was publication of the IEEE Standard 488-1975 defining an interface and communications bus for programmable instruments. This bus is commonly called the GPIB—the General Purpose Interface Bus.

In 1978 the standard was further refined (IEEE Standard 488-1978) defining an interfacing system that has become a widely accepted instrument industry standard. The major areas it specifies are:

1. Mechanical—the interface connector and cable. See Table 1.
2. Electrical—the logic signal levels and how the signals are sent and received.
3. Functional—the tasks an instrument's interface may perform—such as sending data, receiving data, triggering the instrument, etc.—and the protocols to be used. See Table 2.

Today, a wide variety of instruments include interfaces conforming to this mechanical, electrical, and functional standard. These GPIB-compatible instruments and instrument controllers make it possible to achieve the benefits of automated test systems without paying the previous price of custom system design. With GPIB compatibility, measurement capability can be chosen off-the-shelf and simply cabled with standard bus cables in either a linear or star configuration.

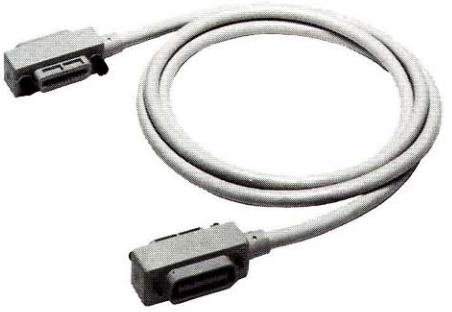


**TABLE 1**
**GPIB HARDWARE CHARACTERISTICS SUMMARY**

- Cable lengths up to and not exceeding 20 meters (approximately 66 feet) with a device load required for every 2 meters of cable.
- Up to 15 devices (1 controller and 14 instruments) may be connected in linear or star configurations.
- Voltages are generally TTL-compatible.
- GPIB signal and data lines are asserted (or true) when pulled low ($\leq +0.8$ V) and released (or false) when pulled high ($\geq +2.0$ V).
- Maximum data rate of up to 250 kilobytes/second over a distance of 20 meters with 2 meters per device or faster with some special restrictions (refer to IEEE Standard 488-1978 for details).

**TABLE 2**
**INTERFACE FUNCTIONS DEFINED BY IEEE STANDARD 488-1978**

| Function | Description |
|---|---|
| Source Handshake (SH) | Synchronizes message transmission |
| Acceptor Handshake (AH) | Synchronizes message reception |
| Talker (T) | Allows instrument to send data |
| Listener (L) | Allows instrument to receive data |
| Service Request (SR) | Requests service from controller |
| Remote-Local (RL) | Allows instrument to select between GPIB interface and front-panel programming |
| Parallel Poll (PP) | Allows up to eight instruments to simultaneously return a status bit to the controller |
| Device Clear (DC) | Puts instrument in known state |
| Device Trigger (DT) | Starts some basic operation of the instrument |
| Controller (C) | Sends device addresses and other interface messages |

## Tektronix' Systems Experience

Long before publication of the IEEE Standard 488-1975, Tektronix had entered the test and measurement systems business. The measurement speed and capabilities of the Tektronix automated oscilloscope and Tektronix semiconductor test systems quickly highlighted the benefits to be gained from measurement automation. And just as quickly came the realization that a system interfacing standard was needed. But what standard?

The possibilities of the proposed IEEE Standard 488 were recognized. And, when the IEEE Standard 488 became reality, GPIB compatibility was already an integral part of Tektronix product planning and engineering. The result is that Tektronix is now a recognized major supplier of a full line of GPIB system components—a supplier that puts more than a decade of systems planning, design, and implementation experience into each product.

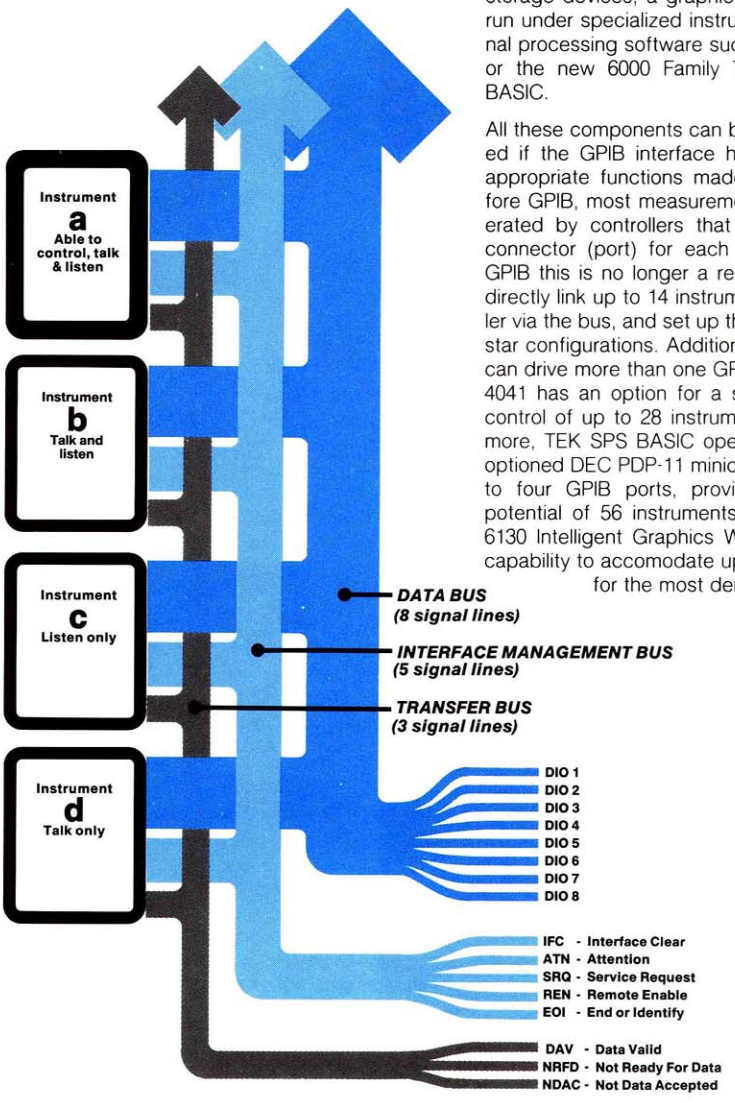
## GPIB System Components

An automated test and measurement system usually consists of the following components:

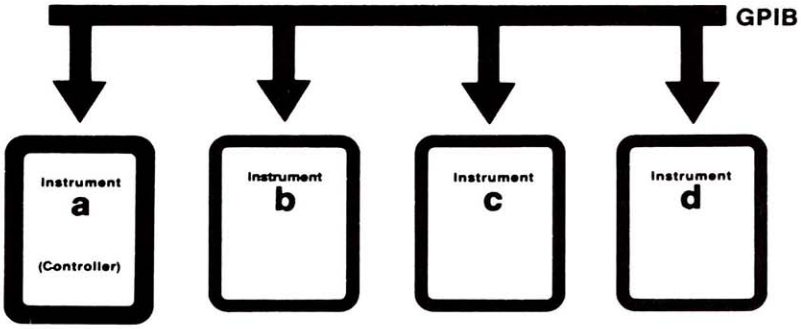
- Multiple instruments: these are either *stimulus* instruments, such as function generators, pulse generators, and power supplies; or *measurement* instruments, such as counters, waveform digitizers, and multimeters.
- Controller with software: this tells the instruments what to do, collects the results, and processes them. The system controller is generally a small computer. The software or firmware operating system must have a powerful, flexible I/O structure to handle GPIB bus traffic. It must also have processing power for waveform manipulation and graphics power for display.
- Computer peripherals: these are devices such as tape drives, printers, and plotters that store or display the results of the tests.
- A keyboard: this enables the user to send commands or information to the system.
- A display: the display allows the user to review intermediate results and to monitor system operation.

For smaller systems, one or more of these last three components are often incorporated in the system controller. Larger, more powerful systems, however, may be minicomputer-based, augmented by one or more high-speed mass storage devices, a graphic display terminal, and run under specialized instrument control and signal processing software such as TEK SPS BASIC or the new 6000 Family Tek (proposed) ANSI BASIC.

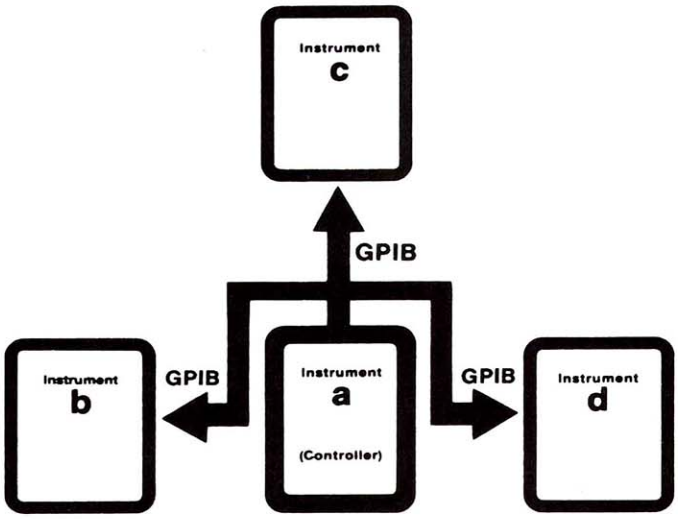
All these components can be easily interconnected if the GPIB interface has been built in and appropriate functions made programmable. Before GPIB, most measurement systems were operated by controllers that required a separate connector (port) for each instrument. With the GPIB this is no longer a requirement. Users can directly link up to 14 instruments with the controller via the bus, and set up the systems in linear or star configurations. Additionally, some controllers can drive more than one GPIB port. The Tektronix 4041 has an option for a second port, allowing control of up to 28 instruments. Or, if you need more, TEK SPS BASIC operated with a properly optioned DEC PDP-11 minicomputer can drive up to four GPIB ports, providing a total system potential of 56 instruments. The new 6120 and 6130 Intelligent Graphics Workstations have the capability to accomodate up to seven GPIB ports for the most demanding applications.



## Linear Configuration




## Star Configuration




All these devices (the controller, measurement instruments, and peripherals) comprise the hardware. The system cannot operate, however, unless it is driven by software.

There are two levels of software necessary, the operating system software and user written application programs. The operating system software provides a set of commands and functions that the user combines into a program that delineates the measurement and processing task to be performed. The software, guided by the user program, works through the controller to tell the instruments what signals to generate, what measurements to make, and tells the controller what to do with the results.

The software and the program in the controller make the system do what the user wants. The GPIB interface allows users to plug system components together, but without software, the system can do nothing.

In programmable instrument systems, the "language" of the software or program has several meanings:

1. The controller has its own language, such as BASIC, and users must express their intentions in this language.
2. Within the context of the controller's language, the instrument's commands (or "language") have to be sent over the GPIB.
3. The actual control of the GPIB interface is transparent to the user with Tektronix instrument controllers and software.

In order to make the system operate, the user has to:

1. Know what tasks the system is to perform—the system can do nothing by itself.
2. Know the controller's language.
3. Know the kind of data or language the instruments are designed to exchange.

To make these tasks easier for you, Tektronix has taken several steps beyond simple IEEE Standard 488-1978 compatibility. Consistency has been designed into each system component for the greatest degree of compatibility. Intelligence has been designed in to relieve you from interfacing details. And firmware and software have been designed and written to provide the maximum in programming ease and measurement capability.

### Consistency Makes a Big Difference

Tektronix GPIB products are designed and thoroughly evaluated for compliance with IEEE Standard 488-1978 and for compatibility with one another. Because these products are designed to be compatible (i.e., meet the same standards), users usually won't need to make hardware and software modifications for each new addition or deletion to the configuration. Many software routines need to be written only once, after which only minor modifications are needed with the addition of new instruments.

A status check routine, for instance, will work on all Tektronix GPIB instruments. A message terminator common to all Tektronix GPIB instruments is a further benefit. But, since the IEEE Standard 488-1978 allows several optional message terminators, Tektronix instruments go an extra step by providing a switch for selecting optional terminators. These features provide users with the capability of quickly configuring and reconfiguring interactive and automated measurement systems.

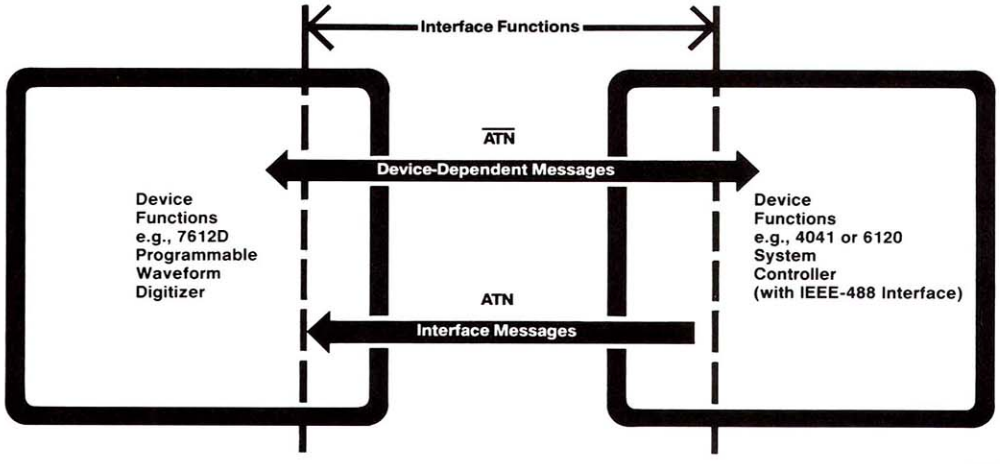
The result is a line of products that are not only GPIB compatible—but are capable GPIB instruments. They have the features that make them useful and the compatibility that makes them work together.

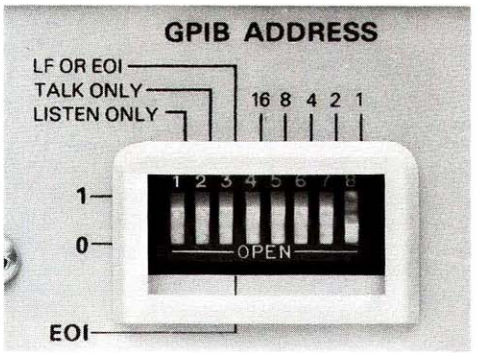
### Tektronix Standard Codes and Formats Means Programming Ease

The IEEE Standard 488-1978 specifies the hardware interface and its basic functional protocol. It also specifies a set of codes called interface messages that control interface functions. However, the IEEE Standard 488-1978 does not specify the syntax or coding of device-dependent messages—the messages that control the programmable features of the instrument.

Since the device-dependent messages are not specified, instruments that conform to the IEEE Standard 488-1978 may use inconvenient or even incompatible message formats. It's much like a telephone system—the hardware link is well defined, but unless both parties speak the same language, communication is impossible. That's why Tektronix developed a codes and formats standard that specifies the syntax and coding of device dependent messages, while retaining full IEEE Standard 488-1978 compatibility. The Tektronix *Standard Codes and Formats* specifies message coding to:

- Be simple and unambiguous.
- Use commands that are common among similar devices.
- Use simple, easy-to-remember mnemonics.






*Each GPIB instrument or peripheral, called a device, must be assigned a different system address; this can be done simply by setting switches, usually located on the back panel of the device.*

The benefits of the Tektronix *Standard Codes and Formats*, a major feature of the Tektronix GPIB communications protocol, are numerous. Because of their natural English-like structure, instrument control commands and messages are easy to use. The result is a GPIB implementation that is specifically designed to overcome the programming rigidity and cumbersome procedures of other GPIB systems.

**ASCII Data Standard**

Since most controllers accept ASCII data directly, Tektronix GPIB instrument commands are coded in ASCII. This eliminates the need for error-prone data conversions or byte-by-byte encoding. For example, to set the center frequency of the 492P Spectrum Analyzer to 1.75 MHz, the command is simply written FREQ 1.75 MHz—no more calculated percentages of full-scale or BCD equivalents. Settings for Tektronix GPIB instruments are sent as ASCII data in human readable form.

**Flexible Formats**

Many minor format items that are aggravations in other systems are also taken care of by Tektronix *Standard Codes and Formats*. For example, Tektronix GPIB instruments accept negative zeros and leading and trailing spaces; they also overlook inconsistent use of upper and lower case letters. And, since truncated numbers can drastically affect measurements, Tektronix GPIB instruments round off rather than truncate: e.g., a value of 2.49 becomes 2.5 rather than 2.4. In short, the built-in intelligence is used to make intelligent decisions. That makes your programming job much less rigid and substantially easier.

**Common Messages**

To make things even easier, Tektronix *Standard Codes and Formats* also specifies messages that are to be common to all Tektronix programmable instruments. For example, you can program your system to learn the current settings of any Tektronix GPIB instrument by sending the instrument the SET? message. Any GPIB compatible instrument from Tektronix—whether it is a waveform digitizer, a programmable power supply, or a function generator—interprets SET? the same way. The instrument firmware gathers the instrument's settings together and assembles them into a human readable message to be sent over the bus to the controlling software. If you know how to operate a function generator, then you already know how to read a settings message from a Tektronix GPIB compatible function generator.

*Tektronix 4041 System Controller*

**BASIC Languages**

Because users are increasingly interacting with GPIB systems at the controller keyboard rather than at instrument panels, GPIB systems must be as friendly as possible. This means, too, that the controller languages should be simple, logical, and easy to interpret and implement. That's why BASIC, the established language for Tektronix instrument controllers, is the preferred language of Tektronix *Standard Codes and Formats*.

BASIC is an established language with wide use and familiarity. It is also an English-like language that is easy to learn and understand. So, combined with the English-like messages used with Tektronix GPIB instruments, it becomes a consistent and familiar means of communicating with your system. And your program listings are easy to read and follow, with very little interpretation required. (For more details on Tektronix *Standard Codes and Formats*, ask your Tektronix Sales Engineer or Representative.)

## Controllers to Match Your Needs

Tektronix offers controller-software packages to meet varying GPIB system needs. These packages are:

- The 4041 System Controller, optimized for instrument control in a variety of situations.
- The 6000 Family of Intelligent Workstations, with 32-bit processor capabilities and excellent GPIB control.
- TEK SPS BASIC software with the DEC PDP-11 Series and DEC MICRO/PDP-11 minicomputers, optimized for systems with full waveform acquisition, processing, and graphics.

**The 4041 System Controller**

The 4041 System Controller is a compact, modular controller designed for rackmount, bench-top, or portable use. Its operating system language is an extended BASIC designed for use by both the casual and the sophisticated programmer.

The 4041 controller contains three microprocessors, with the CPU being the powerful 16-bit 68000. Standard memory is 32 kilobytes with optional expansion to a maximum of 160 kilobytes. A 20-character alphanumeric LED display, a 20-character thermal printer, a DC 100 cartridge drive, 18 function keys, a GPIB port, an RS-232 port, and a real-time clock and calendar capability are all standard. An additional GPIB/RS-232 port pair is optional, with the second GPIB port having Direct Memory Access capability. With 14 GPIB instruments per GPIB port, the 4041 System Controller offers the capability of controlling up to 28 GPIB instruments. Other options include an 8-bit parallel TTL interface (Option 02); SCSI (Small Computer System Interface, Option 03, for external disk mass storage and a second RS-232 port) to support interfacing to floppy and hard disks for greater file and data storage; and a detachable program development/debug keyboard.

The capabilities of standard 4041 BASIC can be expanded by installing ROM (Read-Only Memory) packs to extend operational features of the 4041 into a broad range of systems applications, with functions running faster than equivalent BASIC routines.

The program development ROMs (with keyboard, or an RS-232 terminal), give the engineer or production test programmer access to the system language. Its English-like commands, simple syntax, and line-by-line interpreter implementation combine for a friendly and interactive system. A variety of other features are also included to increase friendliness. For example, vaiable names may be up to eight characters long, allowing meaningful names such as RISETIME, VOLTAGE 1, or DELAY. And as another example, subprograms and program lines can be named—e.g., 1000 SRQPOLL: or 200 RMS VOLTS—for quick and easy access.

Beyond enhancements for simplicity, 4041 BASIC also has enhancements that make it a powerful tool for sophisticated programmers, too. It includes capabilities for FORTRAN-like subprograms, variable passing from main program to subprograms, declaration of local and global variables, and many other features.

Yet, for all its sophistication, the 4041 is still particularly desirable for use by lower-skill operators in a production environment. Instrument control programs can be designed and written to print user prompts on the 4041 display and the programs can be assigned to any of the ten user-definable keys on the 4041 front panel. Then the 4041 program development ROM and keyboard can be removed from the controller. This puts the 4041 into an execute only mode with its programs protected. The lower-skill user need only follow the front-panel display prompts and press the designated keys to execute programs.

To return to the engineering or program development mode, simply plug the program development ROMs (with keyboard or an RS-232 terminal) back into the 4041. You again have access to all of the ease and power of 4041 BASIC programming.

The 4041R01 Graphics ROM pack gives the 4041 the capability to generate graphic commands to interact with peripheral devices using Tektronix compatible graphic codes. These high-level and primitive commands allow you to construct and incorporate graphic images, symbols, charts and diagrams into your system applications greatly enhancing system usability.

The 4041R02 Plotting ROM Pack gives the 4041 the capability to generate graphs and to plot data. Designed as an easy-to-use tool to automatically generate scientific graphics, the plotting ROM pack requires the presence of the 4041R01 Graphics ROM Pack in order to operate. Graphs can be generated and displayed on any graphic peripheral device supported by the 4041R01. The automatic plotting commands are the heart of the 4041R02. These commands, given your data, draw axes with appropriate tic marks and plot the desired data. You need little experience to program graphics or plotting routines. All you need to do is supply the data to be graphed.

The 4041R03 Signal Processing ROM Pack gives the 4041 the ability to support instrumentation system applications requiring waveform processing. Coupled with our programmable digitizers and oscilloscopes, it will produce broader system configurations and effective solutions for signal analysis. The functions contained in the 4041R03 provide a high level approach to deal with signal processing applications normally solved by lengthy programs requiring extensive knowledge of waveform processing and computer fundamentals. Combined with the graphics and plotting ROM packs, the 4041R03 allows you to produce, analyze and display waveforms semiautomatically.

The 4041R04 Utility ROM Pack adds still more general purpose capabilities to your 4041. These range from such convenience items as one line descriptions of error codes to capabilities for building PROM files for programming your own EPROMS.

*6120 Intelligent Graphics Workstation*

**6000 Family of Intelligent Graphics Workstations**

The ***NEW*** 6000 workstation products are a family of expandable, low-cost, intelligent graphics systems that combine state-of-the-art microprocessor technology, advanced architectures, and flexible system software. The products were designed to meet a wide range of computing system applications. Configurations range from execute-only instrument controllers to sophisticated engineering workstations based on UNIX*.

**GPIB Interface**

An important 6100 Series feature is a standard GPIB interface that supports programmable instruments such as oscilloscopes, digitizers, audio test systems, multimeters, function generators, spectrum analyzers, and logic analyzers. As with other Tek GPIB based products, the 6100 Series GPIB conforms to the IEEE-488 standards and to Tektronix' own *Standard Codes and Formats* that specifies the syntax and coding of device-dependent messages.

The standard GPIB interface is capable of transferring data and messages at speeds up to 25 kbytes per second and of supporting up to 15 GPIB-compatible instruments. The instruments are classified as either controllers, talkers or listeners. The controller supervises the GPIB, determining which instruments send and receive data over the bus. A talker sends messages and data over the bus, and a listener receives messages and data. The 6100 Series programmable interface allows the user to specify device-dependent parameters, such as primary and secondary addresses, end-of-message and end-of-header delimiters.

In addition to the standard GPIB, each 6100 Series workstation can support up to six additional high-speed GPIB ports. These high-speed ports use direct memory access (DMA) to transfer block data into a cache memory at rates up to 250 kbytes per second.

The primary language used for 6100 Series GPIB communication is Tek's own version of the new (proposed) ANSI BASIC. This version includes 39 GPIB-related routines and has the capability of detecting seven different GPIB conditions. Because it is a compiled rather than an interpreted version, program execution is extremely quick. In addition to having all the standard features of the proposed ANSI BASIC, Tek's version adds GPIB functionality, extended I/O, array slices (which facilitates matrix manipulation), I/O enhancements, and an easy-to-use programming environment and compiler. A 4050 sifter program provides a utility for converting 4050 programs into Tek ANSI BASIC format.

Among the I/O enhancements of Tek's ANSI BASIC is the ability to handle synchronous or asynchronous communications automatically, eliminating complicated addressing and control commands. Another is the ability to perform byte level transfers while retaining full control of all GPIB conditions. Tek's BASIC can communicate with the bus itself or with any instrument on the bus.

** UNIX is a registered trademark of AT&T Bell Laboratories, Inc..*

**TEK SPS BASIC Software with DEC PDP-11 Minicomputers**

When equipped with Tektronix supplied GPIB interfaces, DEC PDP-11 Series minicomputers can be operated with TEK SPS BASIC software to provide the most powerful of big-system instrument control and signal processing. A wide variety of peripherals can be handled, including plotters, line printers, graphic terminals, magnetic tapes, and single or multiple disk storage systems. Additionally, with the proper options, up to four GPIB interface ports can be supported. This means control of and data collection from up to 56 GPIB instruments.

*Tektronix MS 4201 Acquisition/Processing Measurement System using TEK SPS BASIC and a DEC PDP-11 Minicomputer.*

Two versions of TEK SPS BASIC are available, the standard version and the extended memory version. The extended memory version permits processing of very large arrays in computers having up to 128 kilowords of memory with memory management.

Other than memory differences, both versions of TEK SPS BASIC software have the same major features. These include a modular architecture consisting of a resident monitor and an expandable library of over 100 nonresident commands. This unique design lets you configure a software system to meet your specific needs yet leaves the system open for adding new commands and processing modules.

Measurement data can be stored and accessed in a variety of ways. Information can be read or written in either ASCII or binary. Named files can be accessed on hard or flexible disks, magnetic tape, or cassettes. Information can be read from files either sequentially or randomly. TEK SPS BASIC commands give you complete file management capability.

Comprehensive graphics permit waveform plots and X-Y plots between waveforms. Either can be done with single commands. The output is complete with scaled and labeled axes and can be hard-copied to paper.

There's also data logging capabilities for automated waveform capture. And the software's better than 7-digit precision means much higher resolution than possible in conventional oscilloscope measurements. Plus, there are special data structures to retain both numeric and literal information (scale factors and units) associated with a given waveform. This waveform data structure, as well as numeric arrays or portions of numeric arrays, can be operated on arithmetically as easily as can simple numeric variables.

Beyond extending the standard mathematical operations and functions to include waveform processing, TEK SPS BASIC also provides special waveform processing functions. Waveforms can be integrated, differentiated, convolved, correlated, and fast Fourier transformed—all with single commands. Polar conversions can also be performed with a single command to present results as magnitude and phase.

With its large array size capabilities (limited only by memory in most cases), advanced signal processing, and program and instrument tasking capabilities (including error control for independent operation), TEK SPS BASIC offers all of the flexibility and power necessary to control anything from the simplest to the most sophisticated test and measurement system.

## Guide for Selecting GPIB Instruments

When selecting GPIB instruments for a specific application, be sure to check several key specifications for suitability in the configuration.

First, make sure that the instrument can make the desired measurements. Next, determine that the interface functions are compatible with the proposed usage and with other instruments in the GPIB configuration. The following items should be used as a checklist with your sales representative when considering instruments to be used in GPIB configurations:

1. Is the instrument intended for interactive measurement analysis or automated measurement; i.e., are all necessary instrument functions remotely programmable, or will an operator be available to adjust settings?
2. Does the instrument's GPIB interface have the necessary set of functions implemented at the desired level? (For example, AH1 is needed for any useful interaction, SH1 is required for instruments supplying measurements to the controller.)
3. Are diagnostics available to check out the instrument from the front panel or over the GPIB interface?
4. Does the instrument use standard codes and formats conventions for terminators, numeric formats, etc.?
5. Can the instrument's front-panel setting be read from the controller and saved for later automated set up?
6. Can the front panel be "locked out" via the GPIB?

## Tektronix Support for Your GPIB System

With GPIB products and signal processing systems from Tektronix, you're not left on your own after the product is purchased. Tektronix offers complete support and training for the operation and maintenance of its GPIB products and systems.

Every product is shipped with a complete and comprehensive operating manual. Additionally, a variety of training services are available. Training classes are available both at our home office and at selected sites around the world.

As part of the long-term support for GPIB products and systems, Tektronix offers a variety of application literature and support.

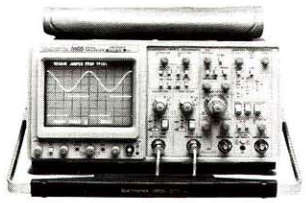
*HANDSHAKE* is an applications newsletter from Tektronix published quarterly and contains application and technical articles covering the broad spectrum of instrument control and signal processing.

The Tektronix Instrumentation Software Library provides software and application information for Tektronix programmable measurement instruments and systems. There are three types of software currently available: Measurement Software, Instrument Utility Software, and User-Exchange Software. The Tektronix Instrumentation Software Library catalog provides program abstracts and ordering information.

An extensive collection of application notes and magazine article reprints is another source of information offered by Tektronix. Our Field Offices and Sales Representatives maintain a list of current literature and will be glad to supply you with items in your areas of interest.

Warranties and service are another part of the support you get from Tektronix. Tektronix maintains a network of service centers for your maintenance needs at strategic locations throughout the world.

## DATA ACQUISITON PROGRAMMABLE OSCILLOSCOPE



***NEW*** **2465/2445 Option 10**
**Programmable Ocsilloscope*1*2**

300 MHz/150 MHz Bandwidth at Probe Tip

Delta Volts/Delta Time Cursors

Optional: Counter, Timer, Trigger/DMM, Word Recognizer, Video Measurements

Measurement Results of CRT Readout Available Over the Bus

2465/2445 Oscillscopes can be easily programmed to assist the scope operator in performing a complete sequence of measurements. Front panel settings can be remotely set or changed with display prompting of messages, providing guidance for the operator. The results of voltage, time, frequency, phase, and ratio can both be displayed on the CRT and be read back over the bus. Also available are three new special edition 2465's with GPIB capabilities. The 2465CTS is ideal for automatic frequency, period, pulse width and time between events measurements; the 2465DMS for automatic test and measurements; and the 2465DVS for high resolution video applications. See page 292.

## WAVEFORM ACQUISITION PRODUCTS

**336 Option 01**
**Digital Storage Oscilloscope**

140 kHz Storage Bandwidth

Time and Voltage Measurement Cursors

50 MHz Nonstorage Bandwidth

CRT Readout, Only 5 kg (11 lbs)

Signal Averaging

This compact oscilloscope can simultaneously display analog and digital waveforms, and can store up to 16 digitized waveforms for recall and display. Vertical and horizontal scale factors, delay time position, and voltage and time readouts of cursor positions are displayed on the CRT, as is a menu of many of the features and modes. An Auto mode for both vertical volts/div and horizontal time/div allows "hands-off" operation in many applications. See page 332.

**468 Option 02**
**Digital Storage Oscilloscope**

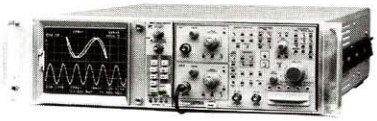
10 MHz Storage Bandwidth

Time and Voltage Measurement Cursors

100 MHz Nonstorage Bandwidth

Signal Averaging

This portable, high-performance oscilloscope uses a unique display interpolation system to store and display single-shot events. Envelope mode can be used to catch glitches, view frequency drift and amplitude modulation, or detect aliasing. Can be used with a 4924 Tape Drive to record waveform data on-site for subsequent filing or computer analysis. Option 02 GPIB interface for outputting waveforms as addressable talker. See page 330.



**7D20/7D20T**
**Programmable Digitizers*1*2**

70 MHz Equivalent Time Bandwidth

40 MHz Sample Rate

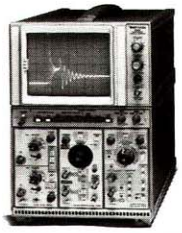
8-Bit Vertical Resolution

Pretrigger and Posttrigger

Simultaneous Acquisition on 2 Channels

The 7D20 plug-in converts any 7000 Series mainframes into fully programmable, digital oscilloscopes. Operating modes include: Envelope, Average, and Roll. Optimized for interactive and automated applications, from biomedical research to radio modulation. Remotely controllable over the GPIB. Shown with R7603 mainframe.

The 7D20T provides the same digitizer capabilities in a compact stand-alone package. See page 333.



**5223 Option 10**
**Digitizing Oscilloscope*1**

1 MHz Equivalent Time Bandwidth

1 MHz Sample Rate

10-Bit Vertical Resolution

Pretrigger and Bi-Slope

X-Y Analog Plotter Output

Roll and Vector Modes

This 10 MHz digital storage oscilloscope provides a digitized display that will never fade or bloom. Selecting Roll mode yields a continually updated display of memory contents by providing a strip-chart-like view of signals at slow sweep rates. Applications range from measuring mechanical displacement transducer signals to biomedical activities. Option 10 GPIB Interface for I/O of stored waveforms and control of 5223 digital storage functions (except vertical and horizontal expansion and position controls). Waveform output format is selectable through this interface for either BINARY or ASCII. Plug-in functions not remotely controllable. See page 344.

**7854 Waveform**
**Processing Oscilloscope*1**

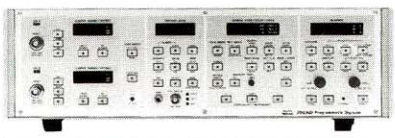
400 MHz Equivalent Time Bandwidth

10-Bit Vertical Resolution

Pretrigger and Posttrigger

Signal Averaging

A two-channel, waveform processing, digital storage oscilloscope. Keystroke programming of local keyboard and remote Waveform Calculator allows user-designed waveform measurement routines for tests or experiments. Signal averaging capability can recover signals buried in noise and improve measurement accuracy. All mainframe keystroke functions and operating modes can be remotely controlled via the GPIB. Plug-in functions not controllable via GPIB. See page 336.



**390AD Programmable Digitizer*1*2**

Cursor-Based Measurements

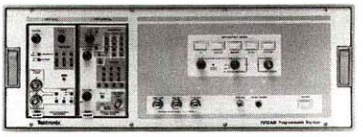
Sample-Rate Switching

Direct Plotter Output Capability

This two-channel, 10-bit digitizer achieves excellent dynamic accuracy with a two-stage flash-conversion process. Single-channel operation can provide 60 megasamples per second. Built-in self-calibration and self-test features. Remotely controllable over the GPIB. Applications vary from ultrasonic testing to video. See page 338.

*1 *Remotely controllable.*
*2 *Fully programmable.*

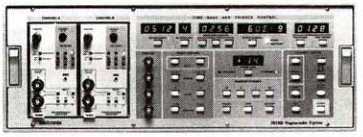
## WAVEFORM ACQUISITION PRODUCTS



**7912AD Programmable Digitizer*1*2**

100 GHz Equivalent Sampling Rate
500 ps/div Calibrated Sweep Rate
500 MHz Bandwidth at 10 mV/div
Built-in Signal Averaging

The 7912AD is designed for interactive and automated applications. It digitizes and stores singleshot or repetitive signals from millisecond to subnanosecond duration. Waveform data is stored in a 4096 word memory. See page 342.



**7612D Programmable Digitizer*1*2**

200 MHz Dual Channel Sampling
Dual Time Base, Sample-Rate Switching
Variable Record Lengths to 2048 Words Each Channel
8-Bit Vertical Resolution
Pretrigger and Posttrigger

Two independent waveform digitizers in one compact instrument, the 7612D is ideal for use with Automatic Test Equipment or anywhere highly accurate, time-domain measurements are required. Memory partitioning helps capture fast, successive, randomly occuring events. Multiple sample rate switching is available during waveform acquisition. Remotely controllable over GPIB. See page 340.

## CONTROLLER-BASED ACQUISITION/PROCESSING MEASUREMENT SYSTEMS

***NEW*** **MS 4101/MS 3101**

Acquisition to 200 MHz w/Program Control
Acquisition to 1 GHz via Direct Access Plug-in
Program and Data Storage on Disk
Waveform and Array Processing
100 GHz Equivalent Sampling Rate
High Resolution Color Graphic Display

The MS 4101 is a self-contained signal acquisition, display, waveform processing, and data storage systems.

The MS 3101 is a complete acquisition, processing, storage, and display system for high-speed signals and transients. Both are based on the Tektronix 7912AD Programmable Digitizer operating with a controller, a Tektronix 4105 Color Graphics Display Terminal and other peripheral equipment. TEK SPS BASIC software includes operational packages and system checkout routines. The controller will accommodate four GPIB Interfaces and features 128 kilowords of memory and floating-point hardware. See pages 351 and 352.

***NEW*** **MS 4201/MS 3201**

Acquisition to 80 MHz w/Program Control
Sampling Rates to 200 MS/s
Waveform and Array Processing
Real Time GPIB Instrument Control
Two Independent Digitizing Channels
High Resolution Color Graphic Display

The MS 4201 is a complete signal acquisition and waveform processing system.

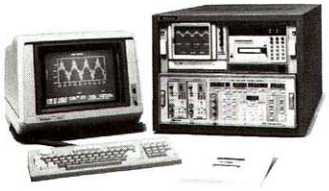
The MS 3201 is a complete acquisition, processing, and storage system for high-speed signals and transients. Both the MS4201 and MS3201 are based on the 7612D Programmable Digitizer operating with a controller, a Tek 4105 Color Graphics Terminal and other peripheral equipment. TEK SPS BASIC Software includes operational packages and system checkout software. The controller will accommodate four GPIB Interfaces and features 128 kilowords of memory and floating-point hardware. See pages 351 and 352.

## DESKTOP CONTROLLER-BASED ACQUISITION/PROCESSING MEASUREMENT PACKAGES

***NEW*** **MP 2501**

Extended Waveform Processing; FFT and IFT
Mag Tape Program and Data Storage
High Resolution Color Graphic Display
GPIB Instrument Control

Based on the Tektronix 7854 Oscilloscope and the 4105 Color Graphics Display Terminal/4041 System Controller equipped with ROM packs, this system can acquire, process, store, and display electrical signals. 4041 BASIC routines from the Utility Software permit system operation with limited programming experience. The 7854 is remotely controllable over the GPIB. See page 350.



***NEW*** **MP 2101**

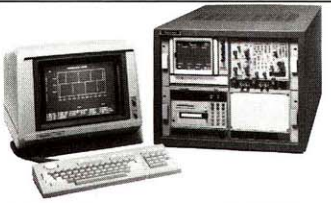
Acquisition to 200 MHz w/Program Control, 1 GHz w/Direct Access Plug-In
100 GHz Equivalent Sampling Rate
High Resolution Color Graphic Display

Based on the Tektronix 7912AD Programmable Digitizer the MP 2101 is a high-speed, signal acquisition and transient digitizing system. The 7912AD is remotely controllable over the GPIB. Utilizes the 4041 with the MP 2501. See page 349.

***NEW*** **MP 2201**

Acquisition to 80 MHz w/Program Control
Two Independent Digitizing Channels
Sampling Rates to 200 MS/s
High Resolution Color Graphics Display

Based on the Tektronix 7612D Programmable Digitizer, the MP 2201 is a complete signal acquisition, waveform processing, storage, and display system. The 7612D is remotely controllable over the GPIB. Utilizes the 4041 with the MP 2501. See page 349.



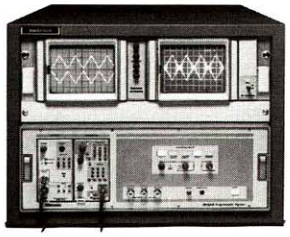
***NEW*** **MP 2401**

Two Channel Acquisition Up To 70 MHz
Ideal for Rugged Environments
GPIB Instrument Control
High Resolution Color Graphics Display

Based on the 7D20T Programmable Digitizer, the MP2401 provides an ideal general purpose signal analysis configuration. Packages dual-channel configuration with enveloping, averaging, cursor measurements, and comparison to prestored waveforms. Supplies functional checkout software for easy diagnostics. See page 349.

*1 Remotely controllable. *2 Fully programmable.

## DESKTOP CONTROLLER-BASED ACQUISITION/PROCESSING MEASUREMENT PACKAGES



***NEW*** **MP 1101**

Ultra High Speed Single-Shot Digital Storage Capability

Nine-Bit Vertical Resolution

Based on the Tektronix 7912AD Programmable Digitizer. This compatible signal acquisition and display package can be front-panel controlled or completely programmed via the GPIB Interface from any suitable controller. See page 349.

***NEW*** **MP 2101**

200 Megasamples/second Maximum Rate, Each Channel

Multi-Records/Channel (Up To 2048 Words Cumulative Total)

Based on the Tektronix 7612D Programmable Digitizer. This compatible signal acquisition and display package can be front-panel controlled or completely programmed via the GPIB Interface from any suitable controller. See page 348.

## INCOMING INSPECTION TEST STATION

***NEW*** **MP 2901**

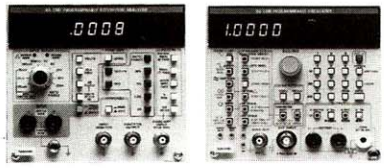
16 Bit MC68000 Based System Controller

Easy Interfacing to Handlers, Probers, and Thermo-Equipment

High Resolution Color Graphics

The MP2901 provides functional and parametric testing capability for a wide range of components and modules. It utilizes the Tektronix 4041 System Controller with 4041 BASIC and TEK EZ-TEST software. See page 350.

## GENERAL PURPOSE INSTRUMENTS

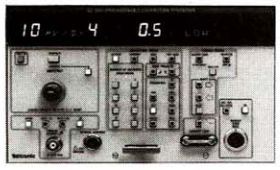


**AA 5001/SG 5010**
**Programmable Audio Test System*[1]**

Fast, Accurate, Repeatable Measurements

Automatic, Low-Cost Documentation of Test Results

Automatically performs such industry-standard tests as harmonic distortion to IHF A202, intermodulation distortion to SMPTE TH 22.51, DIN 45403, IEC 268.3, and IHF A202, frequency response to IHF A202, and noise or signal-to-noise ratio to IHF A202 ("A" weighting filter complies with ANSI specification S1.4 and IEC specification 179 for sound level meters). With the Option 02 capability of the AA 5001, noise measurements may be made to CCIR 468-2 and DIN 45405 standards. The SG 5010 also generates the burst signal for dynamic headroom tests. See page 363.



**CG 5001**
**Programmable Calibration Generator*[1]**

Tests Oscilloscope Current and Voltage Accuracy to ±0.25%

Tests Markers and Slewed-Edge Timing Accuracy to ±0.01%

Verifies Scope Probe Accuracy

A microprocessor-based TM 5000 Series plug-in designed to be an integral part of a controller-based system for calibrating and verifying major oscilloscope parameters. Learn mode allows front panel control settings to be assimilated as program data by controller. All front panel settings are remotely controllable via the GPIB. Contains built-in self test routine. See page 363.

**DC 5009**
**Programmable Universal Counter/Timer*[1]**

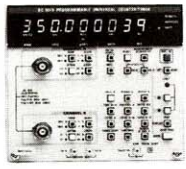
Frequency and Period to 135 MHz

Auto Trigger, Averaging, Self Test

10 ns Clock, Ratio Architecture

Trigger Level and Shaped Outputs

This dual-channel, microprocessor-based TM 5000 Series plug-in provides frequency and period measurement to 135 MHz and features push-button automatic trigger-level setting and 8 measurement functions. An arming input permits measurement of selected events within complex waveforms. Option 01 provides an oven-controlled 10 MHz crystal oscillator. All front panel settings and features are remotely controllable over the GPIB. See page 357.



**DC 5010**
**Programmable Universal Counter/Timer*[1]**

Dc to 350 MHz

Auto Trigger, Auto Averaging

3.125 ns Clock, Ratio Architecture

Arming Input and Shaped Outputs

A dual-channel TM 5000 Series plug-in that provides measurement of frequency to 350 MHz, period, ratio, and event B during A, using a reciprocal technique. Trigger levels automatically set to optimum. Trigger voltage setting is displayable. Automatic self-test feature. Remotely controllable over and fully programmable via GPIB. See page 355.

**DM 5010 Programmable Digital Multimeter*[1]**

4.5 Digit, 0.015% Accuracy

Automatic Self Test, Math Functions

In-Circuit Resistance Measurements

Autoranging

This remotely controllable, TM 5000 Series plug-in measures dc and true RMS ac voltages and resistance. A diode-test function tests semiconductor junctions while a low voltage/ohms function allows in-circuit measurements without turning on diode or transistor junctions. Math functions include: Averaging (up to 19,999 readings), dB (ref to 1 mW or to user-supplied constant). Comparison (user-supplied upper/lower limits). Offset and Scaling (user supplied constants), or any combination of these functions. See page 359.

*[1] *Remotely controllable.*

## GENERAL PURPOSE INSTRUMENTS

**FG 5010**
**Programmable Function Generator*1**

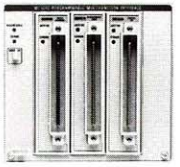
0.002 Hz to 20 MHz ±0.1%

20 mV to 20 V p-p From 50 Ohms

AM, FM, and VCF Modes

Auto Scan Phase Lock

This TM 5000 plug-in outputs Sine, Square and Triangle waveforms. Pulses and Ramps are provided with variable symmetry in 1% steps. Phase-lock mode automatically locks to any input signal, 20 Hz to 20 MHz. Dc offset voltage is programmable from 20 mV to 7.5 V. Can store ten front panel setups to reduce programming time. Fully programmable via GPIB. See page 360.



**MI 5010**
**Programmable Multifunction Interface*1**

User Development Card

16 Relay Scanner, 10 Low Level Relay Scanner

16-Bit & 16 kb Digital I/O

12-Bit D/A & A/D Converter

This TM 5000 Series plug-in interface module accommodates 3 front-panel plug-in cards. The MX 5010 Multifunction Interface Extender provides space for 3 additional cards. A total of 6 function cards can be remotely controlled via the GPIB. Each of the 7 types of function cards includes its own ROM and specific function-related firmware. See page 364.

**PS 5004**
**Programmable Precision Power Supply*1**

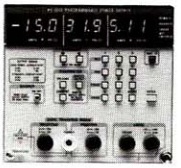
0 V to 20 V Floating Output

0.5 mV/0.1 mA Resolution

Constant Voltage or Constant Current with Autocrossover

Voltage and/or Current Monitoring Display

This TM 5000 Series plug-in provides the high-resolution voltages and currents necessary in the characterization of transistor, IC, and other semiconductor and hybrid circuits and in the operation of high-performance strain gages and other transducer systems. Its entire 0 to 20 V output is covered with a coarse and fine adjustment to provide rapid setability and ±0.5 mV resolution without the necessity of changing ranges. The supply output is available at the rear interface as well as from the front panel terminals. Overall accuracy is ±0.01% ±2 mV. See page 361.



**PS 5010**
**Programmable Triple Power Supply*1**

Triple Output, Triple Display

Programmable Voltage & Current Limit

Front/Rear Outputs, Remote Sense

This TM 5000 plug-in provides three concurrent outputs; two floating at 0 to +32 and 0 to −32 V dc and a logic level suppply at 4.5 to 5.5 V dc. Operation includes auto-crossover with bus interrupt on continuous-voltage or continuous-current mode change. All three supplies may be remotely controlled over the GPIB while front panel settings are locked out. Overall accuracy is ±(0.5% + 20 mV). See page 361.

**SI 5010 Programmable RF Scanner*1**

Software Configurable

Sixteen 50-Ohm Signal Channels

Realtime Clock, 350 MHz Bandwidth

Stores 80 to 300 Commands

This TM 5000 Series plug-in uses sixteen RF reed relays to interconnect twenty front-panel BNC connectors in three possible combinations; four groups of four channels, two groups of eight, or one group of 16. Risetime for groups of four channels is approximately one nanosecond. Used for scanning and channel switching, this device is remotely controllable over the GPIB. See page 367.

## LOGIC ANALYZERS

**DAS 9100 Series Digital Analysis System*1**

Up to 104 Channels of Data Acquisition

Acquisition Speeds to 660 MHz (1.5 ns)

Up to 80 Channels of Pattern Generation at 25 MHz

Color CRT Enhanced User Interface

Easy-to-Use Menu-Driven Interface

A general purpose, configurable, and user-upgradable digital analysis system. Available with black and white display (9109 Option 06 mainframe), without display (9119 ATE mainframe) or with color display (9129 Option 06 mainframe). All of the functions that can be accessed from the DAS 9100 Series keyboard may be controlled via GPIB. The I/O Option 06 supports GPIB data rates up to 200 kbytes per second as well as RS-232, serial line printers, hard copy units and master/slave operation. For list of Data Acquisition and Pattern Generation Modules, accessories and probes see page 108.

**1240 Logic Analyzer**

Up to 72 Acquisition Channels

Acquisition Speeds to 100 MHz Async, 50 MHz Sync

Dual Time Base Acquisition and Display

Simple Menu Operation with On-Screen Soft Keys

The 1240 supports all aspects of the design task, including hardware analysis, software analysis, and integration. For hardware analysis, the 1240 offers up to 36 channels of 100 MHz acquisition with 6 ns glitch detection. Software analysis is supported by up to 72 data channels at sampling rates of 50 MHz synchronous/asynchronous. A flexible clocking scheme includes data demultiplexing on each acquisition probe. Acquisition, triggering and display of 2 independent time bases are tied together, so you can fully monitor the interaction between hardware and software. See page 116.

*1 *Remotely controllable.*

## SYSTEM CONTROLLERS

**4041 System Controller**

16-Bit CPU Based on 68000

32 k RAM, Expandable to 160 k

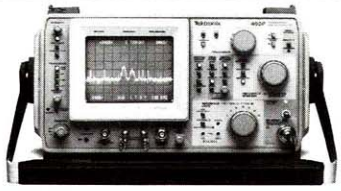
48-File Mag Tape Drive

Full Duplex, Asynchronous, RS-232 Interface

Modular Design, Rackmount or Portable

A powerful and expandable, systems controller intended principally for execute-only environments such as production-line testing. Operating parameters include Interrupt and Error Handling modes. Options and peripherals equip it for interactive flexibility in research lab applications. Programming language is BASIC with English-like commands, extensions, simple syntax, and line-by-line interpreter. A 1.8 lines/second thermal printer is built-in. See page 324.

## SPECTRUM ANALYZERS



**492P Programmable Spectrum Analyzer*[1]**

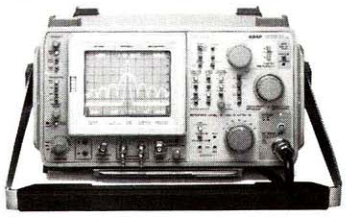
Digital Storage and Signal Processing

80 dB Dynamic Range

Amplitude Comparison in 0.25 dB Steps

100 Hz Resolution Bandwidth

A portable, 50 kHz to 220 GHz, lab quality analyzer that provides CRT readout of all important front panel settings and is fully calibrated in amplitude and frequency. Front panel adjustments can be remotely controlled over the GPIB for automated spectrum analysis via GPIB. Features microprocessor-aided, three-knob operation and flicker-free display even at the slowest sweep speeds. See page 207.



***NEW* 494P**
**Programmable Spectrum Analyzer*[1]**

Microwave Frequency Counter

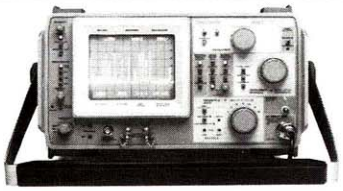
Nonvolatile Memory

Synthesizer Tuning Accuracy

30 Hz Resolution Bandwidth

HELP Manual in ROM

This 10 kHz to 325 GHz portable spectrum analyzer provides lab precision measurement capability in hostile field environments. Full control of the front panel, waveform processing, and storages are accessible via the GPIB. Features keypad data entry, nonvolatile storage of nine CRT displays and ten instrument set-ups, direct plot capability and a built-in 325 GHz frequency counter. See page 202.



**496P Programmable Spectrum Analyzer*[1]**

Digital Storage and Signal Processing

1 kHz to 1800 MHz Input Frequency

80 dB Dynamic Range

Amplitude Comparison in 0.25 dB Steps

30 Hz Resolution Bandwidth

Providing a CRT display of all important control settings, this 1800 MHz analyzer features microprocessor-aided, three-knob operation and automatic mode selection. Unit is fully calibrated in frequency and amplitude. Front panel settings can be remotely controlled. Digital storage eliminates time consuming display adjustments. See page 205.

## INTELLIGENT GRAPHICS WORKSTATIONS

***NEW* 6000 Family Intelligent Graphics Workstation**

32-Bit Processing Power

Based on NS32000 Family of Microprocessors

High Performance Graphics

General Purpose Software Tools

The 6000 Family is made up of two distinct but compatible product groups—the 6100 Series and 6200 Series. Together they offer a product of configurable hardware with a wide range of 32-bit processing power and a choice of graphics capabilities. The products can be configured for a variety of applications, ranging from a programmable controller for production to a powerful CAD workstation with multiple, independent 32-bit CPUs for engineering design. They can be used as stand alone systems or networked together. An integrated software environment provides general purpose productivity tools for document processing, project management and spread sheet analysis. See page 45.

## PERIPHERALS FOR IEEE STANDARD 488 SYSTEMS

**1360P/1360S**
**Programmable Signal Multiplexer*[1]**

3 ms Maximum Switching Time

Dc to 250 MHz Bandwidth (1 Switch)

Input Levels up to 250 V dc or 250 mA

Expandability up to 4 Switch Modules

A microprocessor-based, programmable, system instrument that can be used to multiplex electrical signals. Switch matrix includes four identical, nine-pole coaxial switches. Operational modes determined by adjustable straps. Switch modes are: individual gangs of 1, 2, or 4. Multiples of eight inputs can be multiplexed to one output. See page 367.

*[1] Remotely controllable.*

**RECOMMENDED GPIB CABLES**

| Part Number | Description | Part Number | Description |
|---|---|---|---|
| 012-1015-00 | 0.5 meter, single shield | 012-0991-00 | 2 meters, double shield, low EMI |
| 012-0991-01 | 1 meter, double shield, low EMI | 012-0991-02 | 4 meters, double shield, low EMI |

# INFORMATION DISPLAY PRODUCTS

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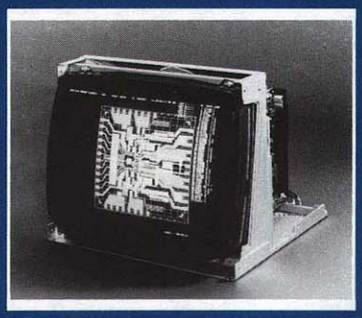
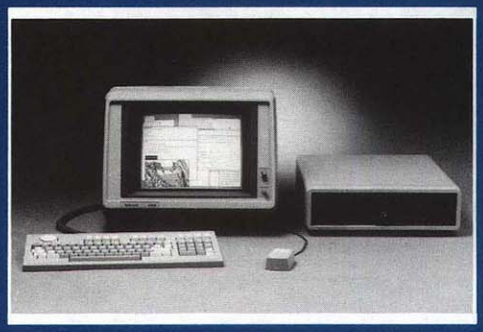
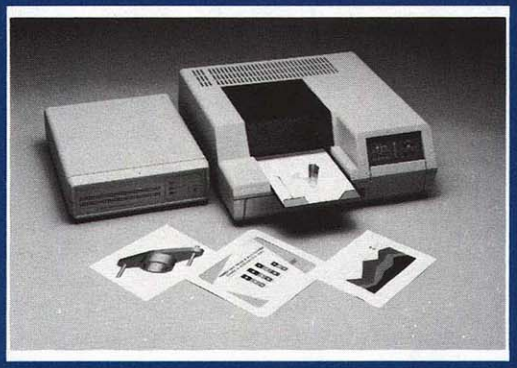
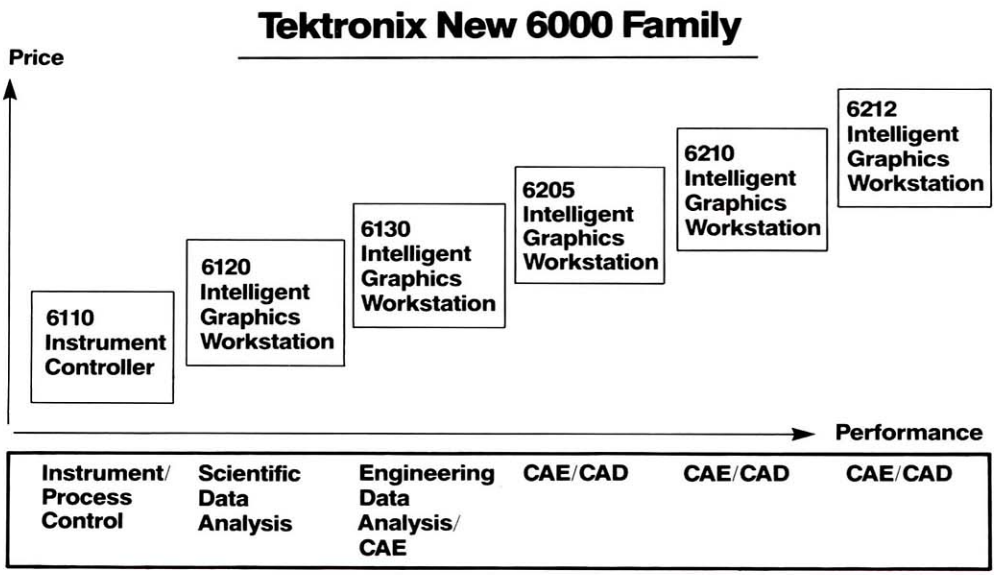






Tektronix sees itself as a company that defines itself not in terms of its products but in terms of its customers. As their needs have expanded — requirements for color, higher speed, local processing, more powerful processing, easier hardware/software integration, more comfortable ergonomic designs — Tek has kept pace by providing state-of-the-art engineering graphic display and computer products at affordable prices.

Tek continues as an industry leader for its product line breadth, its family compatibility, its peripheral support, its use of industry standards and its range of price/performance options. Tek products fill application needs ranging from CAD/CAM to technical data analysis to artificial intelligence (AI). The same graphic capabilities available on our extensive line of host-based graphic terminals are now available in powerful intelligent workstations. Tedious manual digitization of engineering drawings is eliminated with a Tek graphic input workstation. And, Tek color copiers produce hardcopy with resolutions that exceed terminal resolution. Tek innovation, reliability and flexibility are built into all Tek products, which continue to set standards around the world.




## Introducing Tektronix 6000 Family

Developing a workstation strategy is more than a matter of finding "the right" system—because no single configuration can meet the needs of a diverse group of scientists and engineers. Even within a single company or agency, disciplines as varied as electrical engineering, mechanical engineering, software engineering, documentation, data analysis, automated testing, and materials planning need to work together and share data; yet each group has its own specialized computing requirements. To meet those requirements, you look for a mix of display technologies, processing power and software tools; for systems that deliver the right price and performance on each desk; and for products that you can use with your existing equipment, not in place of it.

In the past, Tektronix has supported the needs of scientists and engineers by providing engineering instrumentation, computing controllers, software, and affordable, high-quality graphics terminals. Now, Tek expands its support by offering the 6000 Family—32-bit, high-performance, multifunction workstations that deliver not just a single type of display or level of computing power, but a range of capabilities to handle the full spectrum of scientific and engineering applications.

Also part of the 6000 Family are sophisticated software tools that play a key role in enhancing professionals' productivity. With the 6000 Family, Tek products now span from "dumb" terminals, entirely host dependent, through "smart" terminals with local graphics processing, to "intelligent" graphics workstations powerful enough for standalone applications.

### MEETING A RANGE OF NEEDS

The 6000 Family is made up of two distinct but compatible product groups: the 6100 and 6200 Series. Together, they form a very broad product offering of six different models:

- The 6110 Instrument Controller—a 32-bit execute-only system with a realtime operating system.
- The 6120 Intelligent Graphics Workstation—a 32-bit BASIC-language system designed for scientists and researchers.
- The 6130 Intelligent Graphics Workstation—a low-cost, high-performance 32-bit system with an operating system based on UNIX.*
- The 6205 Intelligent Graphics Workstation—an economical and expandable 32-bit system that offers high-performance graphics and based on UNIX. The 6205 can also be configured as a file or peripheral server for workstations on a Local Area Network (LAN).
- The 6210 Intelligent Graphics Workstation—a system that delivers full 32-bit processing power, high-performance graphics, and based on UNIX. The 6210 can also be configured as a file or peripheral server for workstations on a Local Area Network (LAN).
- The 6212 Intelligent Graphics Workstation—a powerful CAD workstation based on UNIX, with multiple 32-bit CPUs and high-performance graphics.

Along with delivering a range of price/performance ratios for each application, the 6000 Family has the configurability and expandability to fit into your current environment and grow as your requirements change. The 6000 Family is designed to make it easy to add hardware capabilities and peripherals, and to develop and transport applications programs. As a result, you can put together exactly the system you need. In addition, flexible interfacing and a LAN interface mean that the workstations can be used with your existing Tek graphics terminals and with many peripherals and hosts. And both the 6100 and 6200 Series can support multiple users and multiple displays per user.

All members of the 6000 Family share common design goals. The user interface and operating system based on UNIX are the same across the family. The one exception to this is the 6110 Instrument Controller, which has its own Realtime Operating System. (RTOS). This commonality means that users can go from one workstation to another without having to learn new commands and protocols. It also simplifies the task of porting software—an application program ported to one member of the family will run on other similarly-configured 6000 Family workstations.

### A RANGE OF PROCESSING POWER

The 6000 Family is based on National Semiconductor's Series 32000* microprocessors, which feature "mainframe on a chip" architecture and an instruction set designed for efficient execution of high-level-language programs. The 6100 Series uses National's NS32016, a 32-bit processor with a 16-bit data bus, and 32-bit registers and data paths in the chip. The 6200 Series uses the NS32016 for its entry-level workstation, the 6205; and the NS32032, which features a full 32-bit data bus for even higher performance in the 6210 and 6212 workstations. To off-load the CPU and maintain peak throughput, the 6100 and 6200 Series workstation displays use dedicated display processors, and the 6200 Series workstations use an additional I/O processor.

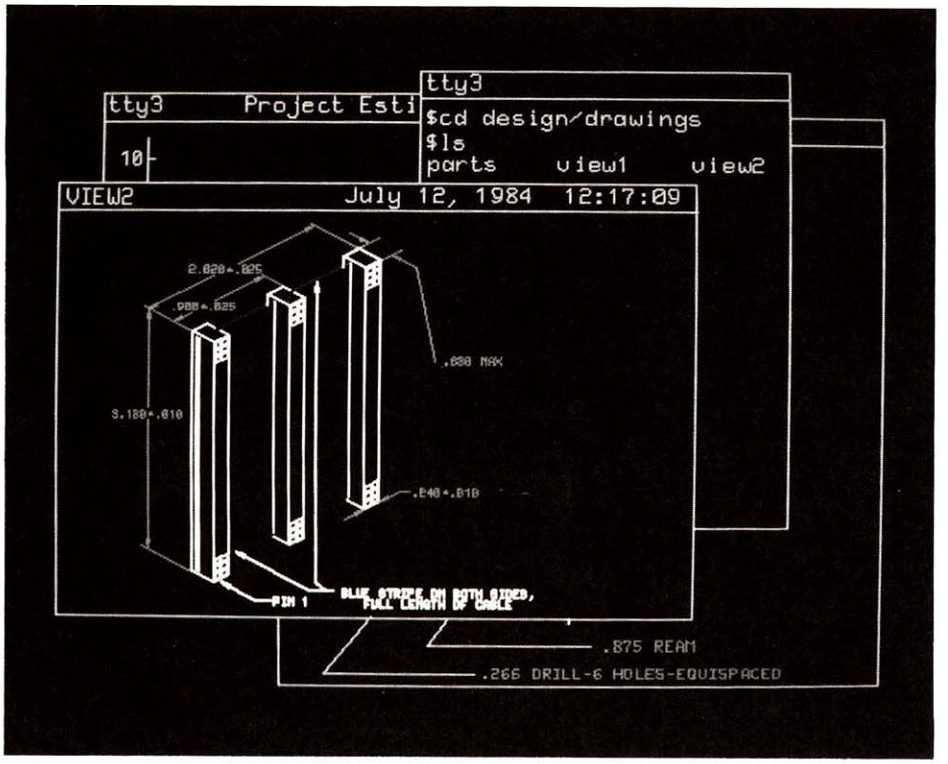
### A RANGE OF DISPLAY SYSTEMS

As important as the range of processing power is the variety of display systems supported. With the 6000 Family, Tektronix adds dynamic, bit/block transfer (BITBLT)/Vector display systems to its extensive line of graphics terminals. The 6000 Family integrated window-managed displays offer a powerful, highly interactive graphics environment that features excellent display list processing, fast vector performance, true zoom and pan, smooth text scrolling, multiple fonts, variable cursors, and rapid pattern-area filling.

Multiple windows, pop-up menus, and a three-button "mouse" make system use both more productive and more enjoyable. Commands are entered by using the mouse as a pointing device to select menu options, locations, or actions. (Conventional command line entry is available, as well.) Windows allow the user to view separate processes that are executing concurrently. Each window is analogous to a terminal, in effect, allowing the user to interact with several terminals simultaneously.

In keeping with the philosophy of the 6000 Family, a range of price/performance display systems are available, including color and monochrome systems. Both the 6100 and 6200 Series displays contain their own 32-bit processors; the 6200 Series adds a microprogrammed display-list processor for enhanced performance. All displays provide a 60 Hz, non-interlaced monitor, detached keyboard with integral keypad, and DEC VT-102 emulation. A Modular User Input Bus can be used to expand the number and type of input devices. See following pages.

** UNIX is a registered trademark of AT&T Bell Laboratories, Inc.*




**4000 and 6000 Series**

In addition to the window-managed displays, the 6000 Family workstations support Tektronix 4010, 4100 and 4110 Series Computer Display Terminals. The 6100 Series can simultaneously support a 6100 Series window-managed display and multiple 4000 Series terminals. The 6200 Series can simultaneously support multiple 6200 Series displays and multiple 4000 Series terminals. This means you'll be able to choose from DVST, color raster and BITBLT/Vector graphics to obtain the display that matches the resolution and interactivity you require. And you can utilize multiple displays/terminals in a single workstation configuration.

**Flexible Interfacing**

A workstation needs to fit into your existing environment. For maximum flexibility in interfacing, the 6000 Family provides RS-232, high-speed serial* and 24-bit parallel* ports. Also supported are a Centronics-compatible hardcopy interface, Multibus, IEEE Standard 488 General Purpose Interface Bus* (GPIB), and high-speed buses. The 6000 Family also supports the Small Computer System Interface* (SCSI), an auxiliary mass storage interface, and IBM PC compatible flexible disk format.

Terminal emulation is available as well, enabling the workstation to function as a terminal to a host computer. The 6000 Family display system can also emulate the DEC VT-102 terminal, and Tektronix 4014 with 4105 color commands. So, for example, host-based software that interacts with a Tektronix 4014 Computer Display Terminal can easily be ported to the 6100 and 6200 Series workstations and interact with the 6000 Family display system. Terminal emulation combines with the display's windowing capability, so that you can open a terminal emulation window to a host while simultaneously executing application programs through other windows.

Workstations can be interconnected to a Local Area Network (LAN) based on the IEEE-802.3 standard, using the TCP/IP protocol. The LAN can also be used for communications with VAX computers running compatible versions of UNIX or VMS. Supporting software handles communication services such as the ability to log in to a remote workstation and transfer files between workstations. A distributed file system is also provided. In addition, the Tektronix operating system, based on UNIX, includes an electronic mail utility that provides user-to-user communications. An optional, fully relational database management system facilitates data sharing among workstations. The LAN also allows workstations to easily share the use of peripherals.

** The 6200 Series will support the high-speed serial, 24-bit parallel, GPIB, and an external SCSI interface beginning mid-1985.*

**THE SOFTWARE STORY**

The 6000 Family workstations provide an integrated, state-of-the-art, user interface and a variety of general-purpose software tools that enhance professional productivity. In addition, the porting of software to the workstations is simplified by the extensive use of software standards and by specialized tools that support the tasks of developing applications programs.

The Casual User Interface (CUI) provides a graphically rich environment that takes advantage of the windowing, mouse, and pop-up menus that are part of the 6000 Family integrated window managed displays. Separate programs can execute in separate windows, and the user can view several files at the same time.

The Casual User Interface is a complete operating environment. The user can move within the CUI to use the conventional operating system interface. Application programs developed or acquired may also be added to the CUI.

The CUI supports the tasks of system and network administration, making it easy to add network nodes or peripherals without detailed knowledge of the operating system.

**The Environment**

Running within the CUI are optional sophisticated personnel productivity tools that together with the CUI and relational database management system, make up THE ENVIRONMENT. The user's interaction techniques are the same for all software within THE ENVIRONMENT, so the learning time spent on any one of the tools applies to the others as well. The following tools are available:

- The Document Processor—a sophisticated and easy-to-use word processing system designed to handle the complex documentation needs of engineers and scientists.
- The Graphics Editor—an interactive, visually-oriented tool for creating conceptual sketches, technical illustrations and presentation graphics, which can then be incorporated into a document created with the Document Processor. The Graphics Editor can also be used to post-edit pictures created in another environment.
- The Project Manager—a set of interactive, graphically-oriented tools for controlling technical project resources, costs and schedules. Activities are easily performed such as producing Gantt and PERT charts, calculating a project's critical path, and producing a variable calendar.

**Relational Database Management**

A powerful, easy-to-use relational database management system can be used within the CUI as well as from the conventional environment which is based on UNIX. This system allows the user to keep information in independent files, instead of locking data into specific programs. These are displayed as simple, easy-to-read tables called "relations." A collection of relations make up a "database." Because the databases are maintained independent of any particular application, different programs can access the same data. This data independence also means you will be able to get answers to questions your programs aren't programmed to ask by using simple, English phrases (through the Query Language). It also allows databases to be reorganized as changing requirements dictate.

The database management system has the following features:

- SQL Query Language—SQL, the IBM standard for Non-Procedural (i.e., not requiring programming) Query Languages, allows the user to ask questions of the database.
- Report Writer—The Report Writer allows users to quickly define reports to be produced from data in databases. These definitions can be edited to reflect changing requirements.
- Program Interface—All the facilities of the database management system are available to any programming language: C, FORTRAN, Pascal, even proposed ANSI BASIC.
- Full Help Facilities—All data management programs have full interactive HELP facilities through the CUI.

The database management system provides a tool for handling the extensive information management needs of today's professionals. It can also be a network resource, allowing users from varied disciplines and locations within a corporation to share data.

**Teknical Tools**

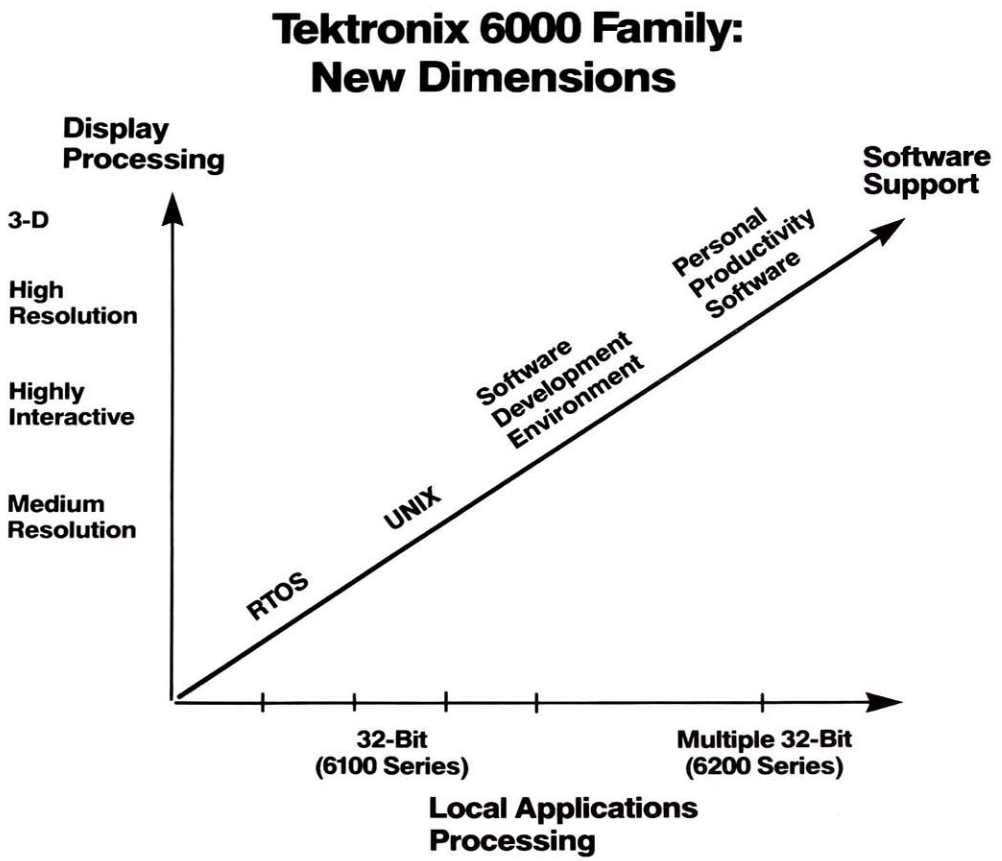
Other 6000 Family personal productivity tools can be used with ANSI terminals, as well as with the 6000 Family integrated window-managed displays:

- Q-ONE—a word processing system with an easy-to-use interface and powerful formatting capabilities.
- Minitab—a general-purpose statistics package with built-in table-formatting and FORTRAN-formatted input and output.
- 20/20—a spreadsheet program that combines graphics and data management capabilities to produce an integrated modeling environment.

**Software Development**

To lower the cost of developing and transporting application programs, the 6000 Family uses an open architecture approach and supports a number of software standards.

In addition, the UIMS (User Interface Management System) allows application programmers to build programs with a sophisticated and consistent user interface. The programs can also use the interface provided by the Casual User Interface. The UIMS provides interactive user-interface language constructs that standardize the user interface across applications while reducing the amount of code to be written by the application developer. Using the UIMS, an applications programmer can interactively specify such user interface issues as the size, location and color of menus and messages.




Standardization begins with the fact that the workstation's operating system is based on UNIX, which is becoming a standard among 16-bit and now 32-bit systems. The Tektronix implementation includes an enhanced version of System V and Berkeley 4.2, with demand paged virtual memory for the efficient execution of very large programs. For languages, the 6000 Family has high-performance compilers for FORTRAN 77, C, and ISO Pascal. Also supported is the proposed ANSI BASIC, which integrates graphics, program segmentation, file processing and structured programming concepts. A language translation utility is available to assist conversion of Tektronix 4050 Series Desktop Computers BASIC programs to the 6000 Family workstations.

The 6100 and 6200 window managed displays are designed to support the Graphical Kernel System (GKS), a standard that brings the advantages of device-independent graphics to workstation applications while maintaining high performance. Also supported are Tektronix PLOT 10 Computer-Aided Drafting (TekniCAD), TCS and IGL.

A large pool of existing UNIX applications programs can run on the workstations. To further expand the possibilities for accessing existing software solutions, the 6120 and 6130 Intelligent Graphics Workstations can add an optional PC Co-Processor that provides compatibility with the MS-DOS operating system.

**A Computing Strategy**

In selecting workstations, you look for systems that support a range of computing and display requirements, allow you to utilize your existing investment in computing hardware and software, and can continue to grow as your requirements change. The 6000 Family workstations meet those needs, and as value-added they have Tek's graphics experience, service and support organization behind them. The 6000 Family gives you not just a workstation but the core of a computing strategy.

The Summary Chart on page 48 shows the range of hardware and software configurations available.

*20/20 is a trademark of Access Technology, Inc.*

*Centronics is a trademark of Centronics Corporation.*
*IBM and IBM PC are trademarks of International Business Machines.*

*Minitab is a trademark of Minitab, Inc.*

*MULTIBUS is a trademark of Intel Corporation.*

*Q-ONE is a trademark of Quadratron Systems, Inc.*

*Series 32000 is a trademark of National Semiconductor Corporation.*

*UNIX is a trademark of AT&T Bell Laboratories, Inc.*

*VAX, VMS and VT-100 are trademarks of Digital Equipment Corporation.*

*MS-DOS is a trademark of Microsoft, Inc.*

## TEKTRONIX 6000 FAMILY HARDWARE SUMMARY

| | 6110 | 6120 | 6130 | 6205/6210 | 6212 |
|---|---|---|---|---|---|
| **Processors** | 32016 CPU | 32016 CPU<br>32081 FP Processor | 32016 CPU<br>32081 FP Processor | 32016 CPU (6205)<br>32032 CPU (6210)<br>32016 I/O Processor<br>32081 FP Processor | Dual 32032 CPUs<br>32016 I/O Processor<br>32081 FP Processor |
| Optional | | PC Co-Processor | PC Co-Processor | 32032 CPU (6210 only) | 32032 CPU |
| **Memory** | 256 k | 1 Mb | 1 Mb | 1 Mb | 4 Mb |
| Optional/Additional | 512 k, or 1 Mb | 1 Mb or 2 Mb | 512 kb, 1 Mb or 2 Mb | 9 Mb | 16 Mb |
| **Storage** | 360 kb diskette | 360 kb diskette<br>10 Mb Winchester | 360 kb diskette<br>20 Mb Winchester | 40 Mb Winchester | 80 Mb Winchester |
| Optional | 10 Mb Winchester | 20 Mb, 40 Mb, or 80 Mb, Winchester (subs)<br>External 40 Mb cart tape | 40 Mb, or 80 Mb Winchester Winchester (subs)<br>External 40 Mb cart tape | 40 Mb or 80 Mb Winchester<br>40 Mb cart tape<br>9-track tape<br>280 Mb SMD disks (1.1 GB max)<br>360 kb diskettes | 40 Mb or 80 Mb Winchester<br>40 Mb cart tape<br>9-track tape<br>280 Mb SMD disks (1.1 GB max)<br>360 kb diskettes |
| **Interface Ports** | RS-232C (2)<br>GPIB<br>LAN | RS-232C (2)<br>GPIB<br>LAN | RS-232C (2)<br>GPIB<br>LAN | RS-232/RS-422<br>RS-232C (3)<br>LAN, 8-bit parallel | RS-232/RS-422<br>RS-232C (3)<br>LAN, 8-bit parallel |
| Optional | High-speed GPIB<br>High-speed serial<br>24-bit parallel<br>8-bit parallel<br>Multibus adaptor<br>Additional Dual RS-232 | High-speed GPIB<br>High-speed serial<br>24-bit parallel<br>8-bit parallel<br>SCSI<br>Multibus adaptor<br>Additional Dual RS-232 | High-speed GPIB<br>High-speed serial<br>24-bit parallel<br>8-bit parallel<br>SCSI<br>Multibus adaptor<br>Additional Dual RS-232 | High-speed GPIB*2<br>High-speed serial*2<br>24-bit parallel*2<br>SCSI*2<br>Multibus adaptor<br>Additional Dual RS-232*2 | High-speed GPIB*2<br>High-speed serial*2<br>24-bit parallel*2<br>SCSI*2<br>Multibus adaptor<br>Additional RS-232*2 |
| **Display Options** | | 32-bit display list processor*1 | 32-bit display list processor*1 | 32-bit display list processor and 24-bit, bit-slice vector processor*1 | 32-bit display list processor and 24-bit, bit-slice vector processor*1 |
| 6000 Family: | | 13 in 640 x 480 color<br>15 in 640 x 480 monochrome | 13 in 640 x 480 color<br>15 in 640x 480 monochrome | 19 in 1024 x 768 color<br>19 in 1024 x 768 monochrome | 19 in 1024 x 768 color<br>19 in 1024 x 768 monochrome |
| 4000 Family: | | 4010 Series<br>4100 Series<br>4110 Series | 4010 Series<br>4100 Series<br>4110 Series | 4010 Series<br>4100 Series<br>4110 Series | 4010 Series<br>4100 Series<br>4110 Series |
| **Peripheral Options** | | | | | |
| 4644 Dot Matrix Printer | yes | yes | yes | yes | yes |
| 4695 Color Graphics Copier | yes | yes | yes | yes | yes |
| Support for Letter Quality Printer | no | no | yes | yes | yes |
| Line Printer | no | no | yes | yes | yes |
| Large-format Plotter | no | no | no | yes | yes |

*1 Display processors come standard in the 6000 Family display systems.

*2 Mid-1985 availability.

## TEKTRONIX 6000 FAMILY SOFTWARE SUMMARY

| | | | | | |
|---|---|---|---|---|---|
| **Operating Systems** | RTOS | Proposed ANSI BASIC<br>Based on UNIX*3 (subset) | Based on UNIX*3 | Based on UNIX*3 | Based on UNIX*3 |
| Optional | | Based on UNIX*7 (full)<br>PC Co-Proc. Support*3*4 | PC Co-Proc. Support*4 | | |
| **Languages** | | Proposed ANSI BASIC | | | |
| Optional | Executes object code from FORTRAN 77, C, ISO Pascal and proposed ANSI BASIC | C*5<br>ISO Pascal*5<br>Enhanced FORTRAN 77*5 | Proposed ANSI BASIC<br>C<br>ISO Pascal<br>Enhanced FORTRAN 77 | Proposed ANSI BASIC<br>C<br>ISO Pascal<br>Enhanced FORTRAN 77 | Proposed ANSI BASIC<br>C<br>ISO Pascal<br>Enhanced FORTRAN 77 |
| **Graphics Libraries** | | GKS Level 0b (subset) | | | |
| Optional | | PLOT 10 IGL*5<br>PLOT 10 TCS*5 | GKS Level 3c<br>PLOT 10 IGL<br>PLOT 10 TCS<br>PLOT 10 TekniCAD | GKS Level 3c<br>PLOT 10 IGL<br>PLOT 10 TCS<br>PLOT 10 TekniCAD | GKS Level 3c<br>PLOT 10 IGL<br>PLOT 10 TCS<br>PLOT 10 TekniCAD |
| **General Purpose Software Options** | | | | | |
| Casual User Interface | no | no | yes*4 | yes*4 | yes*4 |
| Document Processor | no | no | yes*4 | yes*4 | yes*4 |
| Graphics Editor | no | no | yes*4 | yes*4 | yes*4 |
| Project Manager | no | no | yes*4 | yes*4 | yes*4 |
| UIMS | no | no | yes*4 | yes*4 | yes*4 |
| **Database Manager** | no | no | yes | yes | yes |
| Q-ONE | no | Yes*5 | yes | yes | yes |
| Minitab | no | yes*5 | yes | yes | yes |
| 20/20 | no | yes*6 | yes*6 | yes*6 | yes*6 |

*3 Enhanced version of System V and Berkeley 4.2 UNIX.

*4 Requires 6000 Family display system.

*5 Requires additional memory, disk upgrades, and full operating system.

*6 Requires a graphics terminal for plotting.

*7 Requires 20 Mbyte or larger hard disk.

## The 6100 Series

The 6100 Series consists of three products, all with low cost and high performance. They are designed for applications such as process/instrument control, data analysis, and design applications. The 6100 Series is upward compatible with the 6200 Series; applications developed on the 6120 and 6130 will run on the 6200 Series at an increased speed.

The 6100 Series system cabinet is a compact, desk-top unit measuring approximately 6 x 17 x 24 inches and containing six half-wide or three full-wide slots for expansion. The cabinet may be attached to an optional floor stand and placed under or at the side of the work surface.

*6110 Instrument Controller*

### 6110 Instrument Controller

**32-Bit Processor**

**Execute-Only System Controller**

**Realtime Operating System**

**256 Kbytes Memory, 360 Kbytes Flexible Disk Storage**

**Dual RS-232 Ports (Up to 9600 Baud)**

The 6110 is a complete satellite unit for a process control system or instrumentation control. It features a Realtime Operating System and can execute object programs generated in BASIC, C, Pascal, or FORTRAN. Object programs can be downloaded from the other 6000 Family workstations via RS-232, flexible disk, or LAN.

The full-function GPIB port includes talker, listener and controller functions. Other standard 6110 features are 256 kbytes of memory, dual RS-232 ports (up to 9600 baud), and a 360 kbytes flexible disk. Optionally available is a high-speed GPIB port with single-character EOM detection and cache memory transfers.

#### CHARACTERISTICS

**PROCESSOR**

**Standard** — 32016 CPU.

**DATA TRANSMISSION**

**Data Rate** — Up to 9600 baud.
**Interface Ports — Standard:** RS-232C (2), GPIB, LAN.
**Optional** — High-speed GPIB, high-speed serial, 24-bit parallel, 8-bit parallel, Multibus adaptor, additional dual RS-232.

**MEMORY**

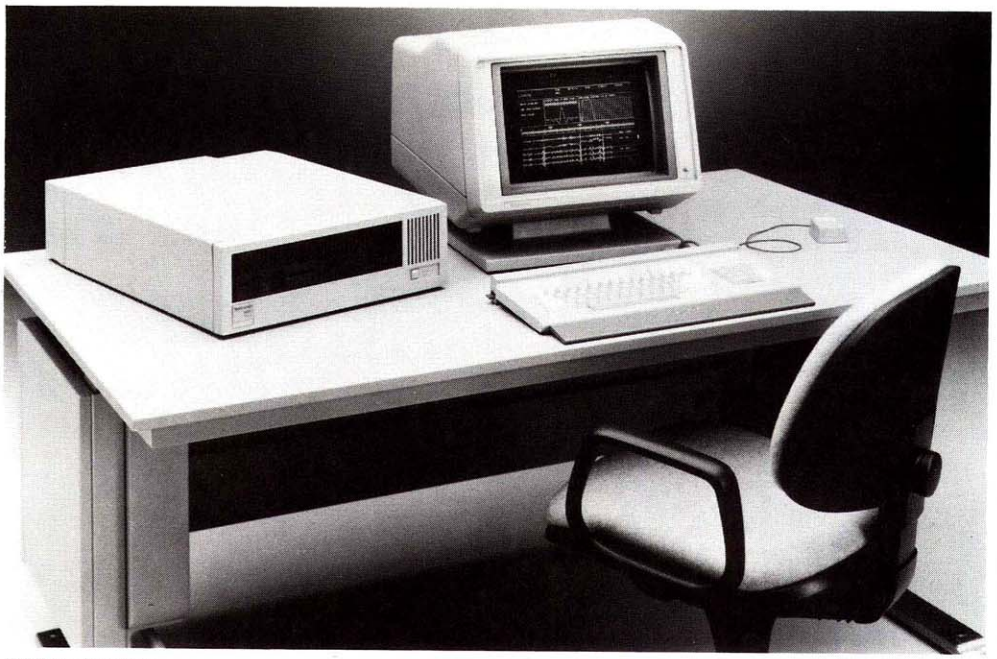
**Standard** — 256 kbytes.
**Optional/Additional** — Up to 1.5 Mbyte.

**STORAGE**

**Standard** — 360 kbytes diskette.
**Optional** — 10 Mbyte Winchester.

**SOFTWARE**

**Operating System** — Realtime Operating System.



*6120 Configuration*

#### ORDERING INFORMATION

**6110** Instrument Controller ..... **$4,995**

***WARRANTY-PLUS* SERVICE PLANS REFER TO PAGE 14**

**N0** — Installation and Setup ..... **+$200**
**N1** — Service Plan + 9 Months Service ..... **+$300**
**N3** — OEM Service Plan +12 Months Service ..... **+$400**

**COMPANION PRODUCT**

**4644** — Matrix Printer ..... **$1,350**

### 6120 Intelligent Graphics Workstation

**32-Bit Processing for Scientific and Research Applications**

**Floating Point Processor**

**Proposed ANSI BASIC**

**GPIB, RS-232C, LAN Interfaces**

**1 Mbyte Memory, 360 Kbytes Flexible Disk and 10 Mbytes Hard Disk Storage**

The 6120 is an excellent system for researchers, mathematicians, and scientists such as astronomers, physicists, biologists, chemists, geologists, zoologists, and oceanographers. The 6120's 32-bit processing power goes hand-in-hand with the ease-of-use and extended capabilities of the proposed ANSI BASIC. The result is perfect for applications such as data acquisition and analysis, scientific and statistical research, data presentation and fore casting.

For increased power and capability, a subset of the 6000 Family operating system, based on UNIX; is included with the BASIC system. It can be accessed directly by the user, to provide a multiuser, multiprocessing environment. With additional disk capacity and memory, compilers for C, FORTRAN, and ISO Pascal can be added. A full version of the operating system is also available.

Optional 6120 integrated window-managed displays include a 15 inch, 640 x 480 monochrome display system and a 13 inch. 640 x 480 color display system with four planes. Both systems include keyboard and mouse input. Additional terminals can be added for multi-user support.

#### CHARACTERISTICS

**PROCESSOR**

**Standard** — 32016 CPU, 32081 Floating Point processor.
**Optional** — PC Co-processor.

**DATA TRANSMISSION**

**Data Rate** — Up to 9600 baud.
**Interface Ports** — Standard: RS-232C (2), GPIB, Local Area Network (LAN). Optional: High-speed GPIB, high-speed serial, 24-bit par- allel, 8-bit parallel, SCSI, Multibus adaptor, additional dual RS-232.

**MEMORY**

**Standard** — 1 Mbyte.
**Optional/Additional** — Up to 2 Mbytes.

**STORAGE**

**Standard** — 360 kbytes diskette, 10 Mbyte Winchester.
**Optional** — 20 Mbyte, 40 Mbyte, or 80 Mbyte Winchester (subs), external 40 Mbyte cartridge tape.

**SOFTWARE**

**Operating System** — Standard: BASIC, and UNIX Subset. Optional: UNIX*1*4 (full), PC Co-processor*2.
**Languages** — Standard: Proposed ANSI BASIC. Optional: Enhanced FORTRAN 77*3, C*3, ISO Pascal*3.
**Graphics Libraries** — Standard: GKS Level Ob. Optional: PLOT 10 IGL*3, PLOT 10 TCS*3.

**OPTIONAL DISPLAY SYSTEMS**

**6000 Family** — 32-bit display processor. Color: 13-inch 640 x 480. Monochrome: 15-inch 640 x 480.
**4000 Family** — 4010, 4100, 4110 Series.
**Refresh Rate** — 60 Hz, non-interlaced.

#### ORDERING INFORMATION

**6120** Intelligent Graphics Workstation (Display not included) ..... **$7,995**

***WARRANTY-PLUS* SERVICE PLANS REFER TO PAGE 14**

**N0** — Installation and Setup ..... **+$250**
**N1** — Service Plan + 9 Months Service ..... **+$470**
**N3** — OEM Service Plan + 12 Months Service ..... **+$630**

**COMPANION PRODUCTS**

**4644** — Dot Matrix Printer ..... **$1,350**
**4695** — Color Graphics Copier ..... **$1,595**

**1 Enhanced version of System V and Berkeley 4.2 UNIX.*
**2 Requires 6000 Family display system.*
**3 Requires disk upgrades and full operating system.*
**4 Requires 20 Mbyte or larger hard disk.*

**OEM terms available on these products.**

NEW

INTELLIGENT WORKSTATIONS

*6130 configuration*

## 6130 Intelligent Graphics Workstation

**Powerful Graphics Workstation for CAE, Data Analysis, and Software Development**

**32-Bit Processor, Floating Point Processor**

**Optional PC Co-processor**

**GPIB, RS-232C, LAN Interfaces**

**1 Mbyte Memory, 360 Kbytes Flexible Disk, 20 Mbytes Hard Disk Storage**

The 6130 is a powerful graphics workstation designed for applications such as data analysis, software development, schematics entry, and computer-aided engineering.

Like the 6200 Series, the 6130's operating system is an enhanced version of System V and Berkeley 4.2 UNIX. For programming support, the 6130 has optional high-performance-compilers for C, FORTRAN, ISO Pascal, and the proposed ANSI BASIC, as well as GKS level 3c support.
An optional PC Co-Processor provides the user with access to a large group of existing software solutions written for the MS-DOS operating system.

Optional 6130 integrated window managed displays include a 15 inch, 640 x 480 monochrome display system and a 13 inch, 640 x 480 color display system with four planes. Both systems include keyboard and mouse input. Additional terminals can be added for multi-user support.

### CHARACTERISTICS

**PROCESSORS**

**Standard** — 32016 CPU, 32081 Floating Point processor.
**Optional** — PC Co-processor.

**DATA TRANSMISSION**

**Data Rate** — Up to 9600 baud.
**Interface Ports** — Standard: RS-232C (2), GPIB, Local Area Network (LAN). Optional: High-speed GPIB, high-speed serial, 24-bit parallel, 8-bit parallel, SCSI, Multibus adaptor, additional dual RS-232.

**MEMORY**

**Standard** — 1 Mbyte.
**Optional/Additional** — Up to 2 Mbytes.

**STORAGE**

**Standard** — 360 kbytes diskette, 20 Mbyte Winchester.
**Optional** — 40 Mbyte or 80 Mbyte Winchester (subs), External 40 Mbyte cartridge tape.

**SOFTWARE**

**Operating System** — Standard: Based on UNIX*1. Optional: PC Co-processor support*2.
**Languages** — Optional: Proposed ANSI BASIC, C, ISO Pascal, Enhanced FORTRAN 77.
**Graphics Libraries** — Optional: GKS Level 3c, PLOT 10 IGL, PLOT 10 TCS, PLOT 10 TekniCAD.

**OPTIONAL DISPLAY SYSTEMS**

**6000 Family** — 32-bit display list processor. Color: 13-inch 640 x 480. Monochrome: 15-inch 640 x 480.
**4000 Family** — 4010, 4100, 4110 Series.
**Refresh Rate** — 60 Hz, non-interlaced.

### ORDERING INFORMATION

**6130** Intelligent Graphics Workstation (Display not Included) ..... **$9,500**

***WARRANTY-PLUS* SERVICE PLANS REFER TO PAGE 14**

**N0** — Installation and Setup ..... **+$250**
**N1** — Service Plan + 9 Months Service ..... **+$515**
**N3** — OEM Service Plan + 12 Months Service ..... **+$685**

**COMPANION PRODUCTS**

**4644** — Dot Matrix Printer ..... **$1,350**
**4695** — Color Graphics Copier ..... **$1,595**

*1 Enhanced version of System V and Berkeley 4.2 UNIX.*
*2 Requires 6000 Family display system.*

**OEM terms available on this product.**

## The 6200 Series

The 6200 Series workstations' high-resolution, window-managed display system, range of processing power, and integrated LAN interface work together to produce flexible and powerful systems suitable for the most demanding tasks. Hardware virtual memory and Floating Point support are standard, as is a dedicated I/O processor.

Along with the flexible interfacing and support for standards that it shares with the 6100 Series, the 6200 Series derives additional power and configurability from its basic internal architecture. The 6200 Series is built around a global bus and uses a state-of-the-art architecture to provide very high performance, long life and adaptability to a variety of cost-performance requirements. And because the underlying operation of the system doesn't depend on the specific components, the workstations can expand, add additional CPUs and special-purpose processors, and even change processor technologies—all at a low incremental cost and without loss of investment.

The 6200 Series workstations can support multiple users, each with a 6200 Series integrated display, Tektronix graphics terminal, or any ANSI terminal. Additionally, multiple displays per user are supported. The 6000 Family multi-processing architecture ensures that the performance degradation sometimes associated with multiple users is minimized.

The 6200 Series workstation cabinet is a deskside unit that is approximately 26 inches high, 8.75 inches wide, and 33.5 inches deep.

*6205 Configuration*

*6210 Configuration*

## 6205 Intelligent Graphics Workstation

### Economical Entry into the High Performance 6200 Series

### NS32016 Processing Power for Multiple Users

The 6205 affords an economical entry into the high-performance 6200 Series product line. It is designed to meet the processing and graphics requirements of computer-aided design and computer-aided engineering applications, and to provide interfacing for the more powerful peripherals that are desirable to support such tasks.

To deliver the processing power needed for multiple users and for CAE/CAD tasks, the 6205's NS32016 central processor, which includes floating point and virtual memory, is aided by an I/O Processor (NS32016) that handles I/O interactions.

The 6205 comes standard with a 40 Mbyte, 5 ½ inch Winchester disk. For increased storage capacity, the 40 Mbyte disk can be replaced by an 80 Mbyte disk, and any one of the following can be added: 40 Mbyte cartridge tape, 360 kbyte flexible disk drive, an additional 40 Mb or 80 Mb Winchester disk.

One megabyte of Error Correcting Code (ECC) RAM is standard for the 6205. The 6205 can support up to 10 Mbyte of memory if terminals are used, up to 6 Mbyte of memory if the 6200 Series monochrome display option is used, and up to 2 Mbyte of memory if the 6200 Series color display option is used. Display systems are optional.

Flexible hardware interfacing is provided by a LAN port; an 8-bit Centronics-compatible hardcopy port; and four high-speed RS-232C ports (19.2 kbaud), one of which can be configured as a high-speed RS-422 serial port.

The 6205 can be configured to act as a special-purpose node such as a file and peripheral server to the other workstations on a Local Area Network. It can be used, for example, as a network node through which other workstations can share peripherals, rather than having the peripherals attached to an individual user's workstation.

To keep pace as your computing needs grow, the 6205, which contains slots for five circuit boards, can be expanded into a 6210 Intelligent Graphics Workstation, with faster 32032-based processing, seven board slots on the system's global bus, and additional peripheral interfacing capacity.

### CHARACTERISTICS

**PROCESSORS**

**Standard** — 32016 CPU, 32016 I/O processor, 32081 Floating Point processor.

**DATA TRANSMISSION**

**RS-232 Data Rate** — Up to 19.2 kbaud.

**Interface Ports** — Standard: RS-232C (3), RS-232/422, Local Area Network (LAN), 8-bit parallel. Optional: High speed GPIB, high speed serial, 24-bit parallel, SCSI, Multibus adaptor, additional RS-232, plotter controller (Mid-1985 availability).

**MEMORY**

**Standard** — 1 Mbyte.

**Optional Additional** — 9 Mbyte.

**STORAGE**

**Standard** — 40 Mbyte Winchester.

**Optional** — 40 Mbyte or 80 Mbyte Winchester, 40 Mbyte cartridge tape, 9-track tape, 280 Mbyte SMD disks (1.1 GB maximum), 360 kbyte diskettes.

**SOFTWARE**

**Operating System** — Based on UNIX*[1].

**Languages** — Optional: Proposed ANSI BASIC, C, ISO Pascal, Enhanced FORTRAN 77.

**Graphics Libraries** — Optional: GKS Level 3c, PLOT 10 IGL, PLOT 10 TCS, PLOT 10 TekniCAD.

**OPTIONAL DISPLAY SYSTEMS**

**6000 Family** — 32-bit display list processor and 24-bit, bit-slice vector processors. Color or Monochrome: 19-inch 1024 x 768.

**4000 Family** — 4010, 4100, 4110 Series.

**Refresh Rate** — 60 Hz, noninterlaced.

### ORDERING INFORMATION

**6205** Intelligent Graphics Workstation (Display Not Included) ..... **$13,950**

***WARRANTY-PLUS* SERVICE PLANS REFER TO PAGE 14**

**N0** — Installation and Setup ..... **+$250**
**N1** — Service Plan + 9 Months Service ..... **+$770**
**N3** — OEM Service Plan + 12 Months Service ..... **+$1,025**

**COMPANION PRODUCTS**

**4644** — Dot Matrix Printer ..... **$1,350**
**4695** — Color Graphics Copier ..... **$1,595**

*[1] Enhanced version of System V and Berkeley 4.2 UNIX.*

## 6210 Intelligent Graphics Workstation

### Multiple-User Configuration for CAE and CAD Engineering Applications

### Dedicated Floating Point, I/O and Display List Processors

### RS-232C, RS-232/422, LAN, 8-Bit Parallel Interfaces

### 1 Mbyte ECC RAM, 40 Mbyte Hard Disk Storage

The 6210 combines 32-bit processing and the high-resolution graphics of the 6200 Series display in a system that is ideal for multiple users and for demanding engineering applications such as ECB design, VLSI design, and mechanical design and analysis.

The central applications processor for the 6200 Series is the NS32032, which includes a 32-bit data bus for full 32-bit processing. Floating point and virtual memory hardware are standard. To further increase system performance, an NS32016-based I/O Processor offloads the central processor and handles all input and output interactions. In addition, the optional 6200 Series display systems include their own 32-bit processor. Additional CPUs, each with their own memory, can be added under Tek's unique multiprocessor UNIX kernel.

The 6210 comes standard with a 40 Mbyte, 5 ¼ inch Winchester disk and 1 Mbyte of Error Correcting Code (ECC) RAM. The 40 Mbyte disk can be replaced by a 40 Mbyte or 80 Mbyte disk, along with an additional 9 Mbyte of memory. A 360 kbyte, 5.25 inch flexible disk drive, 40 Mbyte cartridge tape, and an additional 40 Mbyte or 80 Mbyte Winchester are also available. In addition, plug-in controllers are available for high performance SMD disks, 9-track tape drives, and Versatec plotters. Each disk controller can support up to four drives of 280 Mbyte each for 1.1 GB of external disk storage. A special mass storage cabinet is available to house any combination of two disk drives and one 9-track tape.

OEM terms available on these products.

NEW

INTELLIGENT WORKSTATIONS

For increased configuration flexibility, the 6210 has seven circuit board slots; an optional double-wide configuration allows the workstation to support an increased number of board slots. Like the 6205, the 6210 can be configured to act as a file and peripheral server for other workstations on a Local Area Network.

Hardware interfacing for the 6210 includes as standard: four high-speed RS-232C ports (one configurable as RS-422), a Local Area Network port, and an 8-bit, Centronics-compatible hard-copy port.

## CHARACTERISTICS

### PROCESSORS

**Standard** — 32032 CPU, 32016 I/O processor, 32081 Floating Point processor.

**Optional** — 32032 CPU.

### DATA TRANSMISSION

**RS-232 Data Rate** — Up to 19.2 kbaud.

**Interface Ports** — Standard: RS-232C (3), RS-232/422, Local Area Network (LAN), 8-bit parallel. Optional: High-speed GPIB, high-speed serial, 24-bit parallel, SCSI, Multibus adaptor, additional RS-232, plotter controller. (Mid-1985 availabilty.)

### MEMORY

**Standard** — 1 Mbyte.

**Optional/Additional** — 9 Mbyte.

### STORAGE

**Standard** — 40 Mbyte Winchester.

**Optional** — 40 Mbyte or 80 Mbyte Winchester, 40 Mbyte cartridge tape, 9-track tape, 280 Mbyte SMD disks (1.1 GB maximum), 360 kbyte diskettes.

### SOFTWARE

**Operating System** — Based on UNIX*1.

**Languages** — Optional: Proposed ANSI BASIC, C, ISO Pascal, Enhanced FORTRAN 77.

**Graphics Libraries** — Optional: GKS Level 3c, PLOT 10 IGL, PLOT 10 TCS, PLOT 10 TekniCAD.

### OPTIONAL DISPLAY SYSTEMS

**6000 Family** — 32-bit display list processor, and 24-bit, bit-slice vector processor. Color or Monochrome: 19-inch 1024 x 768.

**4000 Family** — 4010, 4100, 4110 Series.

**Refresh Rate** — 60 Hz, noninterlaced.

## ORDERING INFORMATION

**6210** Intelligent Graphics Workstation (Display not Included) ..... **$17,950**

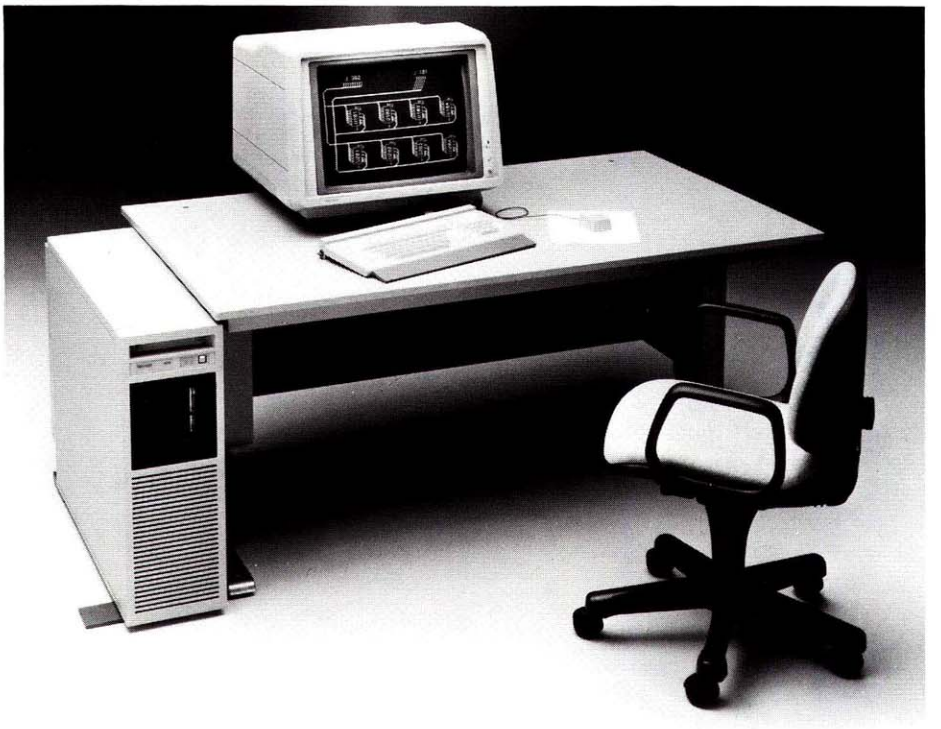
***WARRANTY-PLUS* SERVICE PLANS REFER TO PAGE 14**

**N0** — Installation and Setup ..... **+$300**
**N1** — Service Plan + 9 Months Service ..... **+$470**
**N3** — OEM Service Plan + 12 Months Service ..... **+$630**

### COMPANION PRODUCT

**4644** — Dot Matrix Printer ..... **$1,350**
**4695** — Color Graphics Copier ..... **$1,595**

*1 *Enhanced version of System V and Berkeley 4.2 UNIX.*



*6212 Configuration*

## 6212 Intelligent Graphics Workstation

**Multiprocessing, Multi-User Configuration for Highly Interactive, Compute Intensive Applications**

**Dedicated Floating Point, I/O and Display List Processors**

**RS-232C, RS-232/422, LAN, 8-Bit Parallel Interfaces**

**4 Mbytes Memory, 80 Mbyte Winchester Disk Storage**

The 6212 is the most powerful member of the 6000 Family, although it too can be expanded to include additional CPUs for even higher performance. With seven circuit board slots it can easily support multiple users and multiple displays.

In addition to the capabilities of the 6210, the 6212 features dual applications processors; two 32-bit CPUs are standard, and additional CPUs can be added. Multiple CPUs allow separate tasks—such as editing a schematic and simulating a circuit—to proceed simultaneously on separate CPUs and be monitored via separate windows on the integrated display system.

The 6212's high performance makes it especially suited to tasks that are both highly interactive (such as editing engineering drawings) and highly compute-intensive (such as circuit simulation or finite element analysis). The 6212 provides the local computing power necessary to concurrently perform both interactive and CPU-intensive tasks without relying on a separate host computer.

For memory support for these compute-intensive tasks, the 6212 comes with a standard 2 Mbytes of memory per CPU, and up to 10 Mbytes per CPU is available. Disk capacity is greater than on the 6210, as well; 80 Mbytes is standard, and another 80 Mbytes can be added. All of the 6205 and 6210 options and peripherals are also available, including the 6200 Series integrated window-managed displays.

## CHARACTERISTICS

### PROCESSORS

**Standard** — Dual 32032 CPUs, 32016 I/O processor, 32081 Floating Point processor.
**Optional** — 32032 CPU.

### DATA TRANSMISSION

**RS-232 Data Rate** — Up to 19.2 kbaud.
**Interface Ports** — Standard: RS-232C (3), RS-232/422, Local Area Network (LAN), 8-bit parallel. Optional: High-speed GPIB, high-speed serial, 24-bit parallel, SCSI, Multibus adaptor, additional RS-232, plotter controller (Mid-1985 availability).

### MEMORY

**Standard** — 4 Mbytes.
**Optional/Additional** — 16 Mbytes.

### STORAGE

**Standard** — 80 Mbyte Winchester.
**Optional** — 40 Mbyte or 80 Mbyte Winchester (total of 160 Mbyte), 40 Mbyte cartridge tape, 9-track tape, 280 Mbyte SMD disks (1.1 GB maximum), 360 kbyte diskettes.

### SOFTWARE

**Operating System** — Based on UNIX*1.
**Languages** — Optional: Proposed ANSI BASIC, C, ISO Pascal, Enhanced FORTRAN 77.
**Graphics Libraries** — Optional: GKS Level 3c, PLOT 10 IGL, PLOT 10 TCS, PLOT 10 TekniCAD.

### OPTIONAL DISPLAY SYSTEMS

**6000 Family** — 32-bit display list processor and 24-bit, bit-slice vector processor. Color or Monochrome: 19-inch 1024 x 768.
**4000 Family** — 4010, 4100, 4110 Series.
**Refresh Rate** — 60 Hz, noninterlaced.

**6212** Intelligent Graphics Workstation (Display not Included) ..... **$39,950**

***WARRANTY-PLUS* SERVICE PLANS REFER TO PAGE 14**

**N0** — Installation and Setup ..... **+$300**
**N1** — Service Plan + 9 Months Service ..... **+$1,695**
**N3** — OEM Service Plan + 12 Months Service ..... **+$2,280**

### COMPANION PRODUCTS

**4644** — Dot Matrix Printer ..... **$1,350**
**4695** — Color Graphics Copier ..... **$1,595**

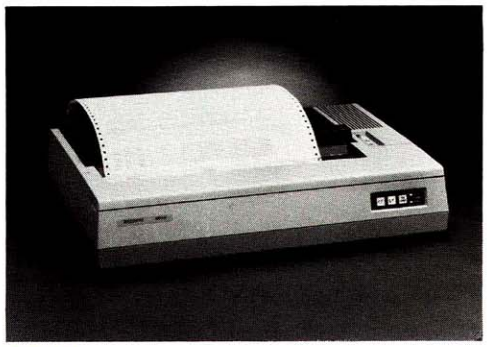
*1 *Enhanced version of System V and Berkeley 4.2 UNIX.*



OEM terms available on this product.

NEW

INTELLIGENT WORKSTATIONS



## 4644 Dot Matrix Printer

**Hardcopy Output for Workstation Printing**

**160 CPS Print Speed**

**High-Resolution Graphics Capability**

**RS-232 and Parallel Interfaced (Centronics Compatible)**

The 4644 Dot Matrix Printer is supported by the 6000 Family Workstations via an RS-232 port or a Centronics-compatible connector. The 4644's compact packaging accommodates full carriage-width printing at a speed of 160 characters per second in a space no larger than that occupied by a standard office typewriter. Multiple pitches allow for pica, elite, condensed and enlarged printing. The 23 x 16 dot matrix permits near-letter-quality printing as a standard capability. High-resolution graphics can be printed at selectable densities of up to 240 dots per inch. A buffer provides non-stop printing. Both tractor and friction-feed are standard.

### CHARACTERISTICS

**Print Speed** — 160 cps draft, 27 cps near-letter-quality.
**Character Set** — 96 ASCII, 7 international.
**Character Density** — 11 x 9 draft, 23 x 16 near-letter-quality.
**Character Pitch** — 5, 6, 8, 10, 12, 17.2 cpi.
**Maximum Columns** — 156 (at 10 cpi).
**Graphics** — 60 to 240 horizontal, 72 to 216 vertical.
**Noise Level** — <60 DBA (≤55 DBA measured).
**Physical Dimensions** — 23.5 in wide x 13.5 in deep x 5.1 in high.

**INCLUDED ACCESSORIES**

Ribbon cartridge (118-3876-00); operator's manual.

### ORDERING INFORMATION

**4644** Dot Matrix Printer ..... **$1,350**

**OPTIONAL ACCESSORIES**

**Ribbon Cartridge** — Order 118-3876-00.*1
**RS-232 Cable** — Order 012-1119-00.*1
**Centronics-Type Cable** — Order 012-1092-00.*1

*1 *Contact your local sales representative.*

This is a preliminary 6000 Family product description. Specifications may change without notice.

## 6210S1 Server Node

**Configured Network Node Based on 6210 Workstation**

**Shared Peripherals**

**1 Mbyte Memory, 40 Mbyte Winchester**

The 6210S1 Server Node functions as a network peripheral "bank" that allows other networked workstations to share large or expensive peripherals. Additionally, it permits the isolation of those peripherals that might exceed comfortable office noise levels. The 6210S1 is a bundled system comprised of a standard 6210 Intelligent Graphics Workstation, a 280 Mbyte SMD disk subsystem, a 9-track tape subsystem, an internal streaming tape cartridge drive, and a Local Area Network (LAN) transceiver. The user can add his own low-cost ANSI terminals or Tektronix 4100 Series terminals.

For product specifications, refer to the 6210 Intelligent Graphics Workstation (page 51) and the various peripheral devices listed on this page.

## 60TD10 9-Track Tape

**Tape Storage for 6200 Series Workstations**

**9-Track, 1600 BPI, Phase-Encoded**

**Streaming and Start/Stop Operation**

The 60TD10 9-track tape is a convenient, industry-standard storage system for 6200 Series Workstations. Using the popular, industry-wide PE (phase-encoded) format, the 60TD10 provides transportable media backup for high-capacity fixed media SMD disks. Both streaming (100 ips) and start/stop modes are available for operational flexibility. The 60TD10 is packaged in a low-profile cabinet (60GC01) that blends easily into workstation environment and allows for easy servicing.

### CHARACTERISTICS

**Recording Density** — 1600 bpi.
**Storage Capacity** — Up to 40 Mbyte on 10.5 in reel.
**Number Tracks** — 9.
**Tape Width** — 1/2 in.
**Recording Format** — PE.
**Streaming Speed** — 100 ips.
**Start/Stop Speed** — 25 ips.
**Rewind Speed** — 2.50 min.
**Interfacing** — Requires 62KM31 9-track tape controller (in 6200 Series Workstation) or user-supplied SCSI interface for 6100 Series.

**INCLUDED ACCESSORIES**

1/2 in tape real, 2400 ft (002-1439-00); installation/operation manual.

### ORDERING INFORMATION

**60TD10** 9-track Tape Drive and Cabinet ..... **$9,950**
**62KM31** Tape Controller ..... **$2,500**

## 60DH01 280 Mbyte SMD Disk

**High-Capacity Disk Storage for 6200 Series Workstations**

The 60DH01 SMD disk provides 280 Mbytes of formatted storage for data-intensive workstation applications or for use as a shared data source in a local area network. The 60DH01 can be packaged in an optional stand-alone mass storage cabinet (60GC01) or it can be easily installed into the 60TD10 9-track tape drive cabinet for a cost-effective storage/backup combination. Each cabinet can house up to two 60DH01's; and up to four drives can be driven by the same 6200 Series controller (62KM30). The 60DH01 provides 20 ms access times (average) and a maximum data rate of 1.2 Mbytes/second.

### CHARACTERISTICS

**Capacity** — 340 Mbytes unformatted, 280 Mbytes formatted.
**Access Time** — 20 ms (average).
**Interfacing** — Requires 62KM30 SMD Disk Controller in 6200 Series Workstation.

**PHYSICAL CHARACTERISTICS**

| | SMD Drive Only 60DH01 | | Tape With Cabinet 60TD10 | | Cabinet Only 60GC01 | |
|---|---|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** | **mm** | **in** |
| Width | 216 | 8.5 | 546 | 21.5 | 546 | 21.5 |
| Height | 259 | 10.2 | 915 | 36.0 | 915 | 36.0 |
| Depth | 762 | 30.0 | 915 | 36.0 | 915 | 36.0 |
| **Weights≈** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** |
| Net | 37.0 | 82.0 | 72.5 | 160.0 | 27.2 | 60.0 |

**INCLUDED ACCESSORIES**

Installation/operation manual

### ORDERING INFORMATION

**60DH01** 300 Mbyte SMD Disk ..... **$15,400**
**62KM30** SMD Disk Controller ..... **$2,900**

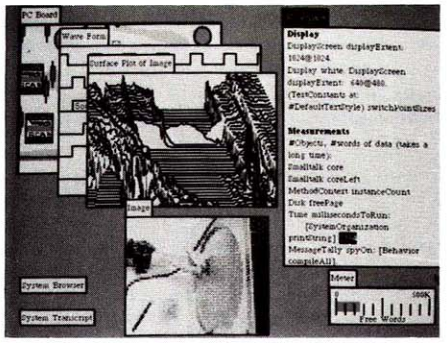
## 60GC01 Mass Storage Cabinet

The 60GC01 Mass Storage Cabinet is a compact, space-saving means of housing up to two SMD Disk Drives (60DH01) and one 60TD10 9-track tape drive. The cabinet is the standard enclosure for the 60TD10 9-track tape drive and may be ordered separately for disk-only configurations.

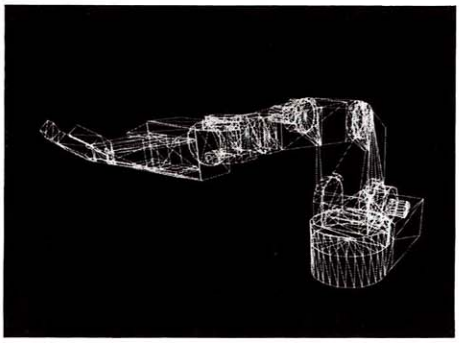
No separate order is required for a disk/tape combination in the same cabinet.

### ORDERING INFORMATION

**60GC01** Mass Storage Cabinet ..... **$1,950**




*4404 Display*



*4115B 3-D wireframe display*

## CONTINUING THE GRAPHICS STANDARD

### Compatibility Across the Board

Compatibility of hardware and software is the basis for building a line of products that can change with market and application requirements, expand as needed, and take advantage of new technologies as they become available. In 1985 Tektronix Information Display Group continues its ongoing commitment to provide customers with the highest quality and the most technologically advanced graphics products. All of Tek's new products are fully compatible with existing product lines, protecting software investments and making hardware upgrades simple and inexpensive. Highlighted here are several new products and enhancements that reinforce Tek's reputation as a leader in high quality color graphics products.

Two new enhancement packages for the 4115B and M4115B Computer Display Terminals debuted this year. Both add power and greater adaptability, extending performance and increasing user productivity. The M4115B's sophistication and interactivity is also configured in another new product introduced by Tektronix this year, the 4991S1 Graphic Input Workstation.

The 4991S1 provides customers with a cost-effective means of inputting vast amounts of graphical data into the data bases of popular CAD systems, resulting in up to ten times productivity increase over manual digitization.

We've augmented our 4100 Series of low-cost color graphics terminals with a new entry, the 4106. And, we've introduced a new color graphics copier, the 4692, that features a patented ink transient suppressor technology for clean, reliable operation. With the new 4510 Color Graphics Rasterizer, users can take advantage of the full resolution of their copiers, rather than limiting hardcopy resolution to that of their terminals.

Pushing back price barriers in yet another technological area, Tek introduced a low-cost artificial intelligence system that supports AI research and provides a viable delivery system for AI-based software, at one half to one eighth the cost of existing AI machines.

Finally, in continuing to meet the needs of our OEM customers, we have made available a family of high-quality computer display monitors featured in our 4100 and 4110 Series graphics terminals.

### Advanced 3-D Wireframe Capability and Feature Extensions

The 4115B and M4115B Computer Display Terminals have been enhanced to include full 3-D wireframe capability, in addition to their existing 2-D feature sets. The 4115F58 3-D wireframe enhancement is particularly useful for such tasks as structural analysis and design, finite element modeling, and thermal vibration analysis. The ability to perform local 3-D matrix transformations is resident in terminal firmware, reducing dependency on the host. The most frequently used 3-D transformations, including rotation, scaling, clipping and skewing, are all available.

A second 4115B enhancement package is a set of four features designed to be downloaded from a host or local disk. The features increase performance and productivity by enabling the user to edit segments without redrawing and retransmitting the image; to call segments from within other segments; to manage windows through pop-up menus and scrolling dialog areas; and to automatically draw circular arcs.

### 4991S1 Graphic Input Workstation

The 4991S1 Graphic Input Workstation was designed to eliminate time-consuming and tedious manual digitization of archived drawings. Consisting of a Tektronix 4991 Autovectorizer, an M4115B Computer Display Terminal, a 4957 Graphics Tablet and proprietary Graphics Structuring and Host Interfacing Software, the 4991S1 represents a tremendous productivity boon to users involved in conversion of existing drawings—on paper, Mylar*[1] or other media—into vector data for storage in CAD data bases.

### New Member of the 4100 Series

The 4106 Computer Display Terminal is an extension to the popular 4100 Series of high-quality, low-cost color graphics terminals. The 4106 broadens the series' price/performance range by offering higher resolution than the 4105 along with the enhanced features of the 4107 terminal (but with less local memory). The 4106 features 640 x 480 resolution, interactive color selection, segment support of up to 4,000 short vectors and VT-100 compatibility. Key application areas include technical data analysis, complex charting and graphing, and sophisticated business graphics.

### High-Resolution Peripherals

The new 4692 Color Graphics Copier offers high-quality A-size color copying from 4100 and 4110 Series color display terminals or from a host using the new 4510 Color Graphics Rasterizer. The 4692 introduces a new standard for ink-jet reliability, featuring a unique ITS (Ink Transient Suppressor) that prevents head clogging. Up to 154 dots per inch addressability in both directions provides crisp, sharp images on either paper or transparency media.

The new 4510 Color Graphics Rasterizer allows the 4691 and 4692 Color Graphics Copiers to produce images at the full resolution of the copiers, rather than the resolution of the terminals. By converting screen images into raster format, the 4510 eliminates jagged lines and smooths blurred characters. The 4510 can also be used to offload host-based workstations of rasterization tasks, increasing system throughput and lowering CPU overhead.

### OEM Monitors

In its new family of display monitors, Tek gives OEM customers even greater latitude in system development. Offerings include a monochrome raster or a selection of color raster monitors, in a variety of screen sizes, with a variety of resolutions, and within a wide price range to meet diverse OEM system-builder needs.

### Low-Cost Artificial Intelligence Tool

The 4404 Artificial Intelligence System is a powerful tool to support AI research and development through a complete exploratory programming environment that includes a powerful microprocessor, mass storage, a sophisticated user interface, optional networking capability, and a proprietary implementation of the Smalltalk-80*[2] programming language. The 4404 increases productivity in application areas such as expert systems, natural languages, intelligent robotics and vision systems.

Product overviews and specifications follow. In many cases, factors such as ergonomic features, display speed and quality, color brilliance and hardcopy quality are best seen to be fully appreciated. We invite you to ask your local Tektronix Sales Engineer for a demonstration. Or, simply indicate your interest on the enclosed reply card.

*[1] Mylar is a registered trademark of E.I duPont de Nemours and Company Inc.*

*[2] Smalltalk-80 is a trademark of Xerox Corporation.*

## 4105 Computer Display Terminal

**Low-Cost, High-Quality Color Graphics and VT100-Compatible Alphanumerics**

**Supported by a Push-button Color Copier and a Local Graphics Processing Module**

**Compatible with Tek 4010, 4100 and 4110 Series Terminals**

**One Year On-Site Warranty—Three Year Option**

**The Tek 4105 is a Color Raster Display Terminal Designed to Bring Color Graphics and Alphanumeric Capabilities Within Easy Reach of Every Technical Professional**

Excellent display quality and ergonomic design facilitate easy creation and editing of color graphics and color text. Flicker-free 60 Hz noninterlaced refresh rate; precision in-line gun with fixed convergence, and antiglare etched screen combine to optimize the clarity and brightness of the terminal's 480 x 360 displayable matrix.

### Windowing

Resolution is enhanced by an addressable display matrix of 4096 x 4096 points. This allows the 4105 to accept data files displayed on terminals such as Tektronix' high resolution 4114B or 4115B. The user can "window in" on any portion of the matrix, and by retransmitting the data from the host, display the selected window with significantly greater detail.

In the graphics mode, the user can access up to eight colors selected from a palette of 64. Colors may be changed locally by using the friendly color user interface. Text may also be specified in as many as eight colors; up to 16 colors may be on-screen simultaneously when both the graphics and alphanumerics planes are displayed. Text editing is in compliance with ANSI X3.64 standards for screen editors.

The alphanumerics surface can be used to display host communications without interfering with the graphics on-screen.

### Ergonomic Design

The 4105 features a low-profile, detached DIN standard keyboard with complete ASCII characters. Integral to the keyboard is an innovative Joydisk for positioning the crosshair cursor or scrolling text in the dialog area. The 4105 can be mounted on an adjustable stand that allows it to be easily tilted up or down, swiveled left or right, lowered or elevated, or moved forward and back.

### Wide-ranging Software Compatibility

The 4105 will accept existing programs written for Tek 4010 Series terminals and is upwardly compatible with the other 4100 desktop terminals and with the 4110 Series terminals. It can be used with a wide range of utility and applications software, including Tektronix' PLOT 10 Interactive Graphics Library (IGL), PLOT 10 Graphical Kernal System (GKS) and PLOT 10 Terminal Control System (TCS); DISSPLA*1 and TELL-A-GRAF*1; SAS/GRAPH*2; and popular personal productivity tools such as WordStar*3, SuperCalc2*4, DR Graph*5 and InfoStar*3. (See page 74 Personal Productivity Tools). The 4105 is also fully VT100-compatible with powerful editing and word processing designed to ANSI X3.64 standards.

### Plug-Compatible Peripheral Devices

A number of plug-compatible peripheral devices further extend the value and versatility of the 4105. These include the 4695 Color Graphics Copier (for high-quality color hard copy), the 4170 Local Graphics Processor (for off-line use of the 4105) and the 4970 Cluster Controller (for operation in synchronous IBM SNA environments).

The 4100 Series color terminals are so reliable, the 90-day industry expected warranty just doesn't apply. 4105 quality is guaranteed by a one-year on-site service warranty, with two and three year extended coverage available.

## CHARACTERISTICS

**DATA TRANSMISSION**

**Data Rate** — Up to 38.4 kbaud.

**Communications Interface** — RS-232C.

**DISPLAY**

**Medium** — Shadow-mask color raster.

**Size** — 330 mm (13 in) diagonal.

**Refresh Rate** — 60 Hz, noninterlaced.

**KEYBOARD**

**Standard Keyboard** — Detached, complete ASCII characters, 14-key numeric keypad.

**User Definable and Programmable Function Keys** — Eight.

**Programmable Keys** — 82.

**Graphic Cursor Control** — Joydisk.

**GRAPHICS MODE**

**Addressability** — 4096 x 4096 points.

**Resolution** — 480 x 360 pixels.

**Line Types** — Solid, seven dashed types.

**Graphic Command Syntax** — PLOT 10 compatible.

**Graphics Primitives** — Vectors, polygons, text.

**Colors** — Eight (independent of alphanumeric colors).

**Palette Selection** — 64.

**ALPHANUMERIC MODE**

**Primary Character Set** — 94 (full ASCII).

**Alternate Character Set** — 94 (International, VT-100, rulings and mathematics).

**Character Format** — 5 x 9 dot matrix in 6 x 12 dot character cell.

**AC POWER**

**Line Voltage** — 87 V ac to 128 V ac or 174 V ac to 250 V ac.

**Line Frequency** — 48 Hz to 66 Hz.

**Power** — 200 W max at 125 V.

**PHYSICAL CHARACTERISTICS**

| Dimensions | Module | | Keyboard | |
|---|---|---|---|---|
| | mm | in | mm | in |
| Width | 419 | 16.5 | 423 | 16.6 |
| Height | 353 | 13.9 | 41 | 1.6 |
| Depth | 495 | 19.5 | 180 | 7.0 |
| Depth (with cables) | 572 | 22.5 | | |
| **Weights** | **kg** | **lb** | **kg** | **lb** |
| Net | 20.0 | 44.0 | 2.3 | 5.0 |

**INCLUDED ACCESSORIES**

8 ft power cord; 12 ft host port RS-232 cable (012-0911-00); pkg of six keyboard overlays (334-5164-00); standard keyboard (119-1592-00); operators manual; programmer's reference manual; reference guide.

## ORDERING INFORMATION

**4105** Computer Display Terminal ..... **$3,995**

**Option 4A** — United Kingdom Keyboard ..... **NC**
**Option 4B** — French Keyboard ..... **NC**
**Option 4C** — Swedish Keyboard ..... **NC**
**Option 4F** — Danish/Norwegian Keyboard ..... **NC**
**Option 4G** — German Keyboard ..... **NC**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

***WARRANTY PLUS* SERVICE PLAN REFER TO PAGE 14**

**N0** — Installation and Setup ..... **+$150**
**N2** — Service Plan + 2 Years Service ..... **+$195**
**N3** — OEM Service Plan + 12 Months Service ..... **+$120**

**OPTIONAL ACCESSORIES**

**RS-232 Loopback Connector** — Order 067-1042-00 ..... **$10**
**Copier Port Loopback Connector** — Order 013-0214-00 . **$20**
**Graticule** — Order 067-1150-00 ..... **$145**
**Service Manual**
**Pixel Operation ROM's** — Order 040-1135-00 ..... **$300**

**COMPANION PRODUCTS**

**ADS01** — Adjustable Display Stand Provides Tilt, Swivel, Elevate and Glide Adjustments ..... **$495**
**4170** — Local Graphics Processing Unit ..... **$5,500**
**4695** — Color Graphics Copier ..... **$1,595**
**4970** — Cluster Controller ..... **$6,200**

*1 DISSPLA and TELL-A-GRAF are trademarks of Integrated Software Systems Corporation.*

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*3 WordStar and InfoStar are registered trademarks of MicroPro International Corporation.*

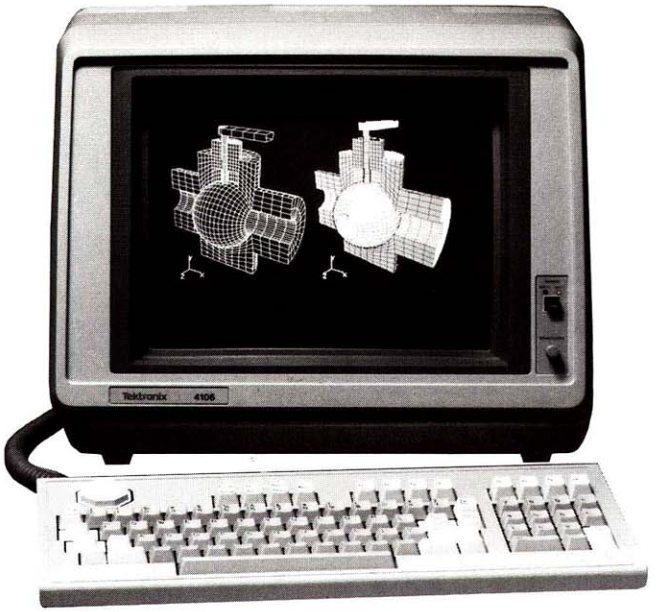
*4 SuperCalc2 is a registered trademark of Sorcim Corporation.*

*5 DR Graph is a trademark of Digital Research.*

**See this color product in the reference section beginning on page 17.**

NEW

COLOR DISPLAY TERMINAL




## 4106 Computer Display Terminal

**Low-Cost, High-Performance Color Graphics and VT100-Compatible Alphanumerics**

**Supported by Push-Button Color Copiers, Color Graphics Rasterizer and Local Graphics Processing Module**

**Compatible with Tek 4010, 4100, and 4110 Series Terminals**

**One Year On-Site Warranty - Three Year Option**

### The Tek 4106 is a Color Raster Terminal that Offers Excellent Display Quality and a Friendly Input Interface to Make Creation and Editing of Color Graphics and Text Incredibly Easy

The flicker-free 60 Hz noninterlaced refresh rate, and shadow-mask color CRT, provides the vivid clarity and brightness of the 4106's 640 x 480, displayable matrix. The 330 mm (13 inch) screen has a 241 mm x 178 mm ( 9 ½ x 7 inch) viewing area. Resolution is enhanced by an addressable display matrix of 4096 x 4096 points.

### Endless Color Graphics Possibilities

Draw solid or dashed lines in up to 16 colors, selectable from a total palatte of 64. Color selections are made quickly and easily through the friendly interface to the color map. Advanced graphics features include multiple views; segments; surface support; user-definable graphtext; and full 4110 graphics input features, including inking, rubberbanding, gridding, user-definable cursor and tablet support.

Alphanumeric information is displayed on a separate surface, so that host communications don't interfere with on-screen graphics.

### Designed for Convenience and Comfort

For maximum productivity, the 4106 features a low-profile, standard DIN detached keyboard with complete ASCII characters; a 14-key numeric keypad; four special-function keys; eight dedicated programmable function keys; and N-key rollover. The 4106 can be mounted on an adjustable stand that allows the display to be tilted up or down, swiveled left or right, lower or elevated, or moved forward and back.

### Wide-Ranging Software Compatibility

The 4106 will accept programs written for Tek 4010 Series terminals and is upwardly compatible with programs for 4100 and 4110 Series terminals. It can be used with a wide range of utility and applications software, including Tektronix' PLOT 10 Interactive Graphics Library (IGL), PLOT 10 Graphical Kernal System (GKS) and PLOT 10 Terminal Control System (TCS); DISSPLA*1 and TELL-A-GRAF*1; SAS/GRAPH*2; and popular personal productivity tools such as WordStar*3, SuperCalc2*4, DR Graph*5 and InfoStar*3. (See page 74 Personal Productivity Tools). The 4106 is also fully VT100-compatible with powerful editing and word processing designed to ANSI X3.64 standards.

### Plug-Compatible Peripheral Devices

These include the 4695 and 4692 Color Graphics Copiers, the 4510 Color Graphics Rasterizer (which eliminates terminal-imposed limitations on copier resolution), the 4170 Local Graphics Processing Unit (for off-line, host-independent use), and 4970 Cluster Controller (for operation in synchronous IBM SNA environments).

4106 quality is guaranteed by a one-year on-site service warranty, with two and three-year extended coverage available.

## CHARACTERISTICS

**DATA TRANSMISSION**

**Data Rate** — 38.4 kbaud.

**Communications Interface** — RS-232C.

**DISPLAY**

**Medium** — Shadow mask color raster.

**Size** — 330 mm (13 inch) diagonal.

**Refresh Rate** — 60 Hz, noninterlaced.

**KEYBOARD**

**Standard Keyboard** — Detached, complete ASCII characters, 14-key numeric keypad.

**User-Definable and Programmable Function Keys** — Eight.

**Programmable Keys** — 82.

**Graphic Cursor Control** — Joydisk.

**GRAPHICS MODE**

**Addressability** — 4096 x 4096 points.

**Resolution** — 640 x 480 pixels.

**Line Types** — Solid, seven dashed types.

**Graphic Command Syntax** — PLOT 10 compatible.

**Colors** — 16.

**Palette Selection** — 64.

**ALPHANUMERIC MODE**

**Primary Character Set** — 94 (full ASCII).

**Alternate Character Set** — 94 (International, VT100, rulings and mathematics).

**Character Format** — 7 x 9 matrix in 8 x 14 dot character cell.

**AC POWER**

**Line Voltage** — 87 V ac to 128 V ac or 174 V ac to 250 V ac.

**Line Frequency** — 48 Hz to 66 Hz.

**Power** — 200 W maximum at 125 V.

**PHYSICAL CHARACTERISTICS**

| Dimensions | Module | | Keyboard | |
|---|---|---|---|---|
| | mm | in | mm | in |
| Width | 419 | 16.5 | 423 | 16.7 |
| Height | 353 | 13.9 | 41 | 1.6 |
| Depth | 495 | 19.5 | 180 | 7.1 |
| Depth (With Cables) | 572 | 22.5 | | |
| **Weights** | **kg** | **lb** | **kg** | **lb** |
| Net | 20.0 | 44.0 | 2.3 | 5.0 |

**INCLUDED ACCESSORIES**

8 ft power cord (161-0066-00); 12 ft host port RS-232 cable (012-0911-00); pkg of six keyboard overlays (334-5164-00); standard keyboard (119-1592-00); operator's manual, programmer reference manual, reference guide.

## ORDERING INFORMATION

**4106** Computer Display Terminal ..... **$6,595**

**Option 4A** — United Kingdom Keyboard ..... **NC**

**Option 4B** — French Keyboard ..... **NC**

**Option 4C** — Swedish Keyboard ..... **NC**

**Option 4F** — Danish/Norwegian Keyboard ..... **NC**

**Option 4G** — German Keyboard ..... **NC**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

**Option A5** — Switzerland 220 V/10 A, 50 Hz

***WARRANTY PLUS* SERVICE PLAN REFER TO PAGE 14**

**N0** — Installation and Setup ..... **+$150**

**N2** — Service Plan +2 Years Service ..... **+$275**

**N3** — OEM Service Plan +12 Months Service ..... **+$195**

**OPTIONAL ACCESSORIES**

**RS-232 Loopback Connector** — Order 067-1042-00 ..... **$10**

**Copier Port Loopback Connector** — Order 013-0214-00 . **$20**

**Graticule** — Order 067-1150-00 ..... **$145**

**Service Manual**

**COMPANION PRODUCTS**

**ADS01** — Adjustable Display Stand Provides Tilt, Swivel, Elevate and Glide Adjustments ..... **$495**

**4170** — Local Graphics Processing Unit ..... **$5,500**

**4510** — Color Graphics Rasterizer ..... **$3,500**

**4692** — Color Graphics Copier ..... **$5,995**

**4695** — Color Graphics Copier ..... **$1,595**

**4970** — Cluster Controller ..... **$6,200**

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**2 SAS/GRAPH is a trademark of SAS Institute, Inc.*

**3 WordStar and InfoStar are registered trademarks of MicroPro International Corporation.*

**4 SuperCalc2 is a registered trademark of Sorcim Corporation.*

**5 DR Graph is a trademark of Digital Research.*

See this color product in the reference section beginning on page 17.



OEM terms available on this product.

## 4107 Computer Display Terminal

**Low-Cost, High-Performance Color Graphics and VT100-Compatible Alphanumerics**

**Supported by Push-button Color Copiers, Color Graphics Rasterizer, and Local Graphics Processing Module**

**Compatible with Tek 4010, 4100, and 4110 Series Terminals**

**One Year On-Site Warranty—Three Year Option**

### The Tek 4107 is a Color Raster Terminal that Rivals Much More Costly Displays in Resolution, Reliability, Alphanumerics Capability, and Local Graphics Manipulation

Excellent display quality and friendly input interface facilitate easy creation and editing of color graphics and color text. Flicker-free 60 Hz noninterlaced refresh rate and shadow mask color CRT combine to optimize the clarity and brightness of the terminal's 640 x 480 displayable matrix.

The resolution is enhanced by an addressable display matrix of 4096 x 4096 points. To view a section in greater detail, the user zooms in on a portion of the display and the 4107 recomputes the coordinate information to display the designated section. Rather than "pixel replication" that simply enlarges the picture without providing additional detail, this true zoom significantly increases resolution.

### Up to 256 k of RAM Permits Picture Elements to be Locally Stored, then Redrawn and Manipulated as Necessary

Users can develop symbols and picture segments pertinent to the application, and recall them saving transmission and CPU time, thus improving interactivity.

The user can select up to 16 colors on the graphics plane from a total palette of 64 colors. Colors can be changed locally by using the friendly interface to the color map. Text may also be specified in as many as eight colors. Text editing is in compliance with ANSI X3.64 standards for screen editors.

Alphanumeric information is displayed on a separate surface that can be used to display host communications without interfering with the graphics on-screen.

### Designed for Comfort and Convenience

For maximum productivity, the 4107 has a low-profile, standard DIN detached keyboard with complete ASCII characters. Integral to the keyboard is an innovative Joydisk for positioning the crosshair cursor or scrolling text in the dialog area. In addition, the 4107 can be mounted on an adjustable stand that allows the terminal to be easily tilted up or down, swiveled left or right, lowered or elevated, or moved forward and back.

The 4107 will accept existing programs written for Tek 4010 Series terminals and is upwardly compatible with programs for 4100 and 4110 Series terminals. It can be used with a wide range of utility and applications software, including Tektronix' PLOT 10 Interactive Graphics Library (IGL), PLOT 10 Graphical Kernal System (GKS) and PLOT 10 Terminal Control System (TCS); DISSPLA*1 and TELL-A-GRAF*1; SAS/GRAPH*2; and popular personal productivity tools such as WordStar*3, SuperCalc2*4, DR Graph*5 and InfoStar*3. (See page 74 Personal Productivity Tools). The 4107 is fully VT100-compatible with powerful editing and word processing designed to ANSI X3.64 standards. The 4107 allows for a smooth transition to higher-end terminals as application needs change.

### Plug-Compatible Peripheral Devices

These include the 4695 and 4692 Color Graphics Copiers, the 4510 Color Graphics Rasterizer (which eliminates terminal-imposed limitations on copier resolution), the 4170 Local Graphics Processing Unit (for off-line, host-independent use), and the 4970 Cluster Controller (for operation in synchronous IBM SNA environments).

The 4100 Series color terminals are so reliable, the 90-day industry expected warranty just doesn't apply. 4107 quality is guaranteed by a one-year on-site service warranty, with two and three-year extended coverage available.

## CHARACTERISTICS

#### DATA TRANSMISSION

**Data Rate** — 38.4 kbaud.

**Communications Interface** — RS-232C.

#### DISPLAY

**Medium** — Shadow mask color raster.

**Size** — 330 mm (13 in) diagonal.

**Refresh Rate** — 60 Hz, noninterlaced.

#### KEYBOARD

**Standard Keyboard** — Detached, complete ASCII characters, 14-key numeric keypad.

**User Definable and Programmable Function Keys** — Eight.

**Programmable Keys** — 82.

**Graphic Cursor Control** — Joydisk.

#### GRAPHICS MODE

**Addressability** — 4096 x 4096 points.

**Resolution** — 640 x 480 pixels.

**Line Types** — Solid, seven dashed types.

**Graphic Command Syntax** — PLOT 10 compatible.

**Colors** — 16.

**Palette Selection** — 64.

#### ALPHANUMERIC MODE

**Primary Character Set** — 94 (full ASCII).

**Alternate Character Set** — 94 (International, VT100, rulings and mathematics).

**Character Format** — 7 x 9 matrix in 8 x 14 dot character cell.

#### AC POWER

**Line Voltage** — 87 V ac to 128 V ac or 174 V ac to 250 V ac.

**Line Frequency** — 48 Hz to 66 Hz.

**Power** — 200 W max at 125 V.

#### PHYSICAL CHARACTERISTICS

| Dimensions | Module | | Keyboard | |
|---|---|---|---|---|
| | mm | in | mm | in |
| Width | 419 | 16.5 | 423 | 16.6 |
| Height | 353 | 13.9 | 41 | 1.6 |
| Depth | 495 | 19.5 | 180 | 7.0 |
| Depth (With Cables) | 572 | 22.5 | | |
| **Weights** | **kg** | **lb** | **kg** | **lb** |
| Net | 20.0 | 44.0 | 2.3 | 5.0 |

#### INCLUDED ACCESSORIES

8 ft power cord (161-0066-00); 12 ft host port RS-232 cable (012-0911-00); pkg of six keyboard overlays (334-5164-00); standard keyboard (119-1592-00); operator's manual, programmer's reference manual, reference guide.

## ORDERING INFORMATION

**4107** Computer Display Terminal ..... **$7,595**

**Option 4A** — United Kingdom Keyboard ..... **NC**
**Option 4B** — French Keyboard ..... **NC**
**Option 4C** — Swedish Keyboard ..... **NC**
**Option 4F** — Danish/Norwegian Keyboard ..... **NC**
**Option 4G** — German Keyboard ..... **NC**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

#### *WARRANTY PLUS* SERVICE PLAN REFER TO PAGE 14

**N0** — Installation and Setup ..... **+$150**
**N2** — Service Plan +2 Years Service ..... **+$325**
**N3** — OEM Service Plan +12 Months Service ..... **+$225**

#### OPTIONAL ACCESSORIES

**RS-232 Loopback Connector** — Order 067-1042-00 ..... **$10**
**Copier Port Loopback Connector** — Order 013-0214-00 . **$20**
**Graticule** — Order 067-1150-00 ..... **$145**
**Service Manual**

#### COMPANION PRODUCTS

**ADS01** — Adjustable Display Stand Provides Tilt, Swivel, Elevate and Glide Adjustments ..... **$495**
**4170** — Local Graphics Processing Unit ..... **$5,500**
**4510** — Color Graphics Rasterizer ..... **$3,500**
**4692** — Color Graphics Copier ..... **$5,995**
**4695** — Color Graphics Copier ..... **$1,595**
**4970** — Cluster Controller ..... **$6,200**

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**4 SuperCalc2 is a registered trademark of Sorcim Corporation.*

**5 DR Graph is a trademark of Digital Research.*

See this color product in the reference section beginning on page 17.

## 4109 Computer Display Terminal

**Low-cost, High-performance Color Graphics and VT100-Compatible Alphanumerics on a 19 Inch Display**

**Select from a Palette of 4096 Colors**

**Supported by Push-button Color Copiers, Color Graphics Rasterizer and a Local Graphics Processing Module**

**Compatible with Tek 4010, 4100 and 4110 Series Terminals**

**One Year On-Site Warranty—Three Year Option**

**The Tek 4109 Computer Display Terminal is a Color Raster Terminal That Rivals Much More Costly Displays in Resolution, Reliability, Alphanumerics Capability and Local Graphics Manipulation**

Excellent display quality and friendly input interface facilitate easy creation and editing of color graphics and color text. Flicker-free 60 Hz noninterlaced refresh rate and shadow mask color CRT combine to optimize the clarity and brightness of the terminal's 640 x 480 displayable matrix.

Effective 4109 resolution is considerably enhanced by an addressable display matrix of 4096 x 4096 points. To view a section in greater detail, the user zooms in on a portion of the display and the 4109 recomputes the coordinate information to display the designated section. Rather than "pixel replication" that simply enlarges the picture without providing additional detail, this true zoom significantly increases resolution.

**Up to 256 k of RAM Permits Picture Elements to be Locally Stored, then Redrawn and Manipulated as Necessary**

Users can develop symbols and picture segments pertinent to the application, and recall them, saving transmission and CPU time, thus improving interactivity.

The user can select up to 16 colors on the graphics plane from a palette of 4096 colors. Colors can be changed locally by using the friendly interface to the color map. Text may also be specified in as many as eight colors. Text editing is in compliance with ANSI X3.64 standards for screen editors. The 4109 can display ASCII complete upper- and lower-case alphanumerics, as well as alternate character fonts.

Alphanumeric information is displayed on a separate surface that can be used to display host communications without interfering with the graphics on-screen.

**Designed for Comfort and Convenience**

The 4109 has a low-profile, standard DIN detached keyboard with complete ASCII characters. Integral to the keyboard is an innovative Joydisk for positioning the crosshair cursor or scrolling text in the dialog area.

The 4109 will accept existing programs written for Tek 4010 and 4100 Series terminals, and is upwardly compatible with 4110 Series terminals. It can be used with a wide range of utility and applications software, including Tektronix' PLOT 10 Interactive Graphics Library (IGL), PLOT 10 Graphical Kernal System (GKS) and PLOT 10 Terminal Control System (TCS); DISSPLA*1 and TELL-A-GRAF*1; SAS/GRAPH*2; and popular personal productivity tools such as WordStar*3, SuperCalc2*4, DR Graph*5 and InfoStar*3. (See page 74 Personal Productivity Tools). The 4109 is also fully VT100-compatible with powerful editing and word processing designed to ANSI X3.64 standards. The 4109 allows for a smooth transition to higher-end terminals as application needs change.

**Plug-Compatible Peripheral Devices**

These include the 4695 and 4692 Color Graphics Copiers, the 4510 Color Graphics Rasterizer (which eliminates terminal-imposed limitations on copier resolution), the 4170 Local Graphics Processing Unit (for off-line, host-independent use), and the 4970 Cluster Controller (for operation in synchronous IBM SNA environments).

The 4100 Series color terminals are so reliable, the 90-day industry expected warranty just doesn't apply. 4109 quality is guaranteed by a one-year on-site service warranty, with two and three-year extended coverage available.

## CHARACTERISTICS

**DATA TRANSMISSION**

**Data Rate** — 38.4 kbaud.
**Communications Interface** — RS-232C.

**DISPLAY**

**Medium** — Shadow mask color raster.
**Size** — 483 mm (19 in) diagonal.
**Refresh Rate** — 60 Hz, noninterlaced.

**KEYBOARD**

**Normal Keyboard** — Detached, complete ASCII characters, 14-key numeric keypad.
**User Definable and Programmable Function Keys** — Eight.
**Programmable Keys** — 82.
**Graphic Cursor Control** — Joydisk.

**GRAPHICS MODE**

**Addressability** — 4096 x 4096 points.
**Resolution** — 640 x 480 pixels.
**Line Types** — Solid, seven dashed types.
**Graphic Command Syntax** — PLOT 10 compatible.
**Colors** — 16.
**Palette Selection** — 4096.

**ALPHANUMERIC MODE**

**Primary Character Set** — 94 (full ASCII).
**Alternate Character Set** — 94 (International, VT-100, rulings and mathematics).
**Character Format** — 7 x 9 matrix in 8 x 14 dot character cell.

**AC POWER**

**Line Voltage** — 87 V ac to 128 V ac or 174 V ac to 250 V ac.
**Line Frequency** — 48 Hz to 66 Hz.
**Power** — 200 W max at 125 V.

**PHYSICAL CHARACTERISTICS**

| Dimensions ≈ | Module | | Keyboard | |
|---|---|---|---|---|
| | mm | in | mm | in |
| Width | 559 | 22.0 | 423 | 16.6 |
| Height | 425 | 16.8 | 41 | 1.6 |
| Depth | 572 | 22.5 | 180 | 7.0 |
| **Weight ≈** | **kg** | **lb** | **kg** | **lb** |
| Net | 31.8 | 70.0 | 2.3 | 5.0 |

**INCLUDED ACCESSORIES**

8 ft power cord (161-0066-00); 12 ft host port RS-232 cable (012-0911-00); pkg of six keyboard overlays (334-5164-00); standard keyboard (119-1592-00); operator's manual, programmer's reference manual; reference guide.

## ORDERING INFORMATION

**4109** Computer Display Terminal ..... **$9,950**
**Option 4A** — United Kingdom Keyboard ..... **NC**
**Option 4B** — French Keyboard ..... **NC**
**Option 4C** — Swedish Keyboard ..... **NC**
**Option 4F** — Danish/Norwegian Keyboard ..... **NC**
**Option 4G** — German Keyboard ..... **NC**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

***WARRANTY PLUS* SERVICE PLANS REFER TO PAGE 14**

**N0** — Installation and Setup ..... **+$150**
**N2** — Service Plan +2 Years Service ..... **+$395**
**N3** — OEM Service Plan +12 Months Service ..... **+$300**

**OPTIONAL ACCESSORIES**

**RS-232 Loopback Connector** — Order 067-1042-00 ..... **$10**
**Copier Port Loopback Connector** — Order 013-0214-00 . **$20**
**Service Manual**

**COMPANION PRODUCTS**

**ADS01** — Adjustable Display Stand Provides Tilt, Swivel, Elevate and Glide Adjustments ..... **$495**
**4170** — Local Graphics Processing Unit ..... **$5,500**
**4510** — Color Graphics Rasterizer ..... **$3,500**
**4692** — Color Graphics Copier ..... **$5,995**
**4695** — Color Graphics Copier ..... **$1,595**
**4970** — Cluster Controller ..... **$6,200**

**1 DISSPLA and TELL-A-GRAF are trademarks of Integrated Software Systems Corporation.*

**2 SAS/GRAPH is a trademark of SAS Institute, Inc.*

**3 WordStar and InfoStar are registered trademarks of MicroPro International Corporation.*

**4 SuperCalc2 is a registered trademark of Sorcim Corporation.*

**5 DR Graph is a trademark of Digital Research.*

See this color product in the reference section beginning on page 17.



OEM terms available on this product.

## 4170 Local Graphics Processing Unit

**Provides Local Intelligence and Graphics Processing to 4100 Series Desktop Terminals**

**Upward-Compatible with 4110 Series Terminals**

**The Tektronix 4170 is a Local Graphics Processing Unit that Provides the 4105, 4106, 4107, and 4109 Computer Display Terminals with Standalone Power Specialized for Graphics Tasks**

It offers all the elements necessary to locally write, edit, compile, link, debug, and run programs; to control 4105, 4106, 4107, or 4109 terminals; and to control peripherals connected to the system.

The 4170 consists of a standalone microprocessor, local mass storage and local memory on an industry standard CP/M-86 operating system, FORTRAN-86 compiler, four serial I/O ports, and Tektronix graphics software support.

### Dual Microprocessors Speed Local Processing

The 4170 is powered by the 16-bit Intel 8086 and the 8087 Numeric Co-processor which speeds floating point operations. The chips provide powerful throughput and 20-bit addressability.

The 4170 comes standard with 256 kbytes of error checking and correcting memory. The 4170's total capacity is 896 kbytes. This provides host independence and more programming workspace in error free local memory.

The 4170 has two 5¼ inch disk drives as standard, allowing work to be easily backed up, system programs and user files maintained separately, and programs changed when necessary. Each formatted diskette can hold 327 kbytes of data. Eight Mbytes of Winchester hard disk storage is optionally available for larger mass storage requirements.

The 4170 allows the user to locally perform pre- and post-processing of graphics information, calling upon the host only when intensive processing is needed. The result is greater host efficiency; the ability to support more terminals and; most importantly, greater individual user productivity in a time sharing environment.

Self-diagnostics make system adjustments quick to identify and repairs readily verified.

## CHARACTERISTICS

### PROCESSORS

Intel 8086 MPU.

Intel 8087 Numeric Co-Processor.

### MEMORY

Port A 375 ns ≤ memory cycle of Port B <1.2 μs.

**Standard** — 256 k Error Checking and Correcting.

**Option 30** — 512 k Error Checking and Correcting.

**Option 31** — 768 k Error Checking and Correcting.

**Option 32** — 896 k Error Checking and Correcting.

### DISK STORAGE

**Standard** — Two each 5¼ in Floppy Disk Drives, 327 k formatted capacity per diskette, IBM P.C. compatible, 125 kbits/s transfer rate.

**Option 03** — 5¼ in Winchester Disk Drive, 8 Mbytes formatted capacity, 5 Mbits/s transfer rate.

### COMMUNICATIONS INTERFACE

**Standard** — Host Port RS-232C DTE, Terminal Port RS-232C DCE, two Peripheral Ports RS-232C DCE.

**Option 10** — Three additional RS-232 Ports, all RS-232 Ports are capable of 300, 600, 1200, 2400, 4800, 9600, 19.2 kbaud.

### COLOR COPIER INTERFACE

**Option 09** — 4690 Series Color Copier Interface.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 224 | 8.8 |
| Height | 597 | 23.5 |
| Depth | 622 | 24.5 |
| Depth (with cables) | 673 | 26.5 |
| **Weight** | **kg** | **lb** |
| Net | 22.2 | 49.0 |

### INCLUDED ACCESSORIES

Cue card (334-0083-00); pkg of 10 blank diskettes (119-1583-01); one set system software diskettes (016-0764-00); 12 ft host port RS-232 cable (012-0911-00); self-test adaptor (067-1043-00); instruction manual.

## ORDERING INFORMATION

**4170** Local Graphics Processing Unit . **$5,500**

**4170F03** — Hard Disk ..... **$3,000**
**4170F09** — Parallel Interface (for Copiers and Plotters) **$500**
**4170F10** — Additional Three-Port Peripheral Interface . **$950**
**4170F30** — Additional 256 k RAM ..... **$1,790**
**4170F31** — Additional 512 k RAM ..... **$3,580**
**4170F32** — Additional 640 k RAM ..... **$4,480**
**4170F44** — Disk Interface Flexible Disk ..... **NC**
**4170F45** — Disk Interface Hard and/or Flexible Disk . **$1,100**

**Above options are field installable, may be factory installed at time of order.**

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

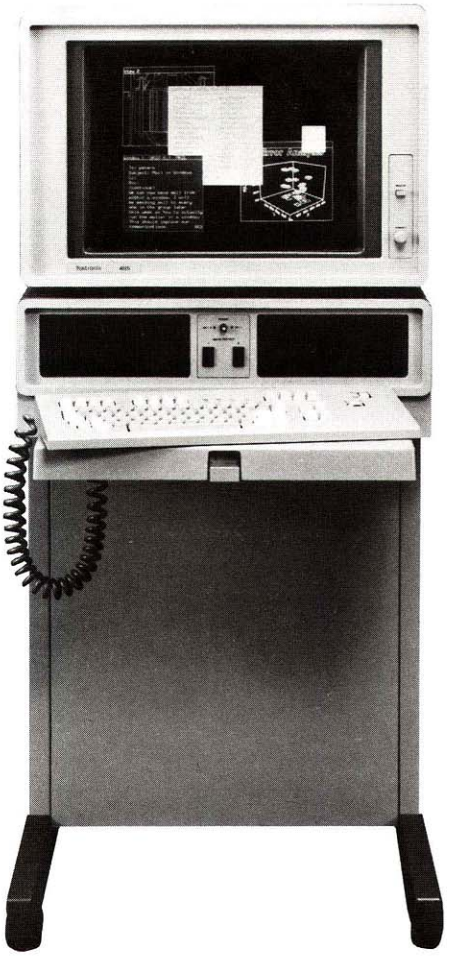
**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

***WARRANTY PLUS* SERVICE PLANS REFER TO PAGE 14**

**N0** — Installation and Set-Up ..... **+$250**
**N1** — Service Plan + 9 Months Service ..... **+$340**
**N3** — OEM Service Plan +12 Months Service ..... **+$455**

### OPTIONAL ACCESSORIES

**Alignment Diskette** Order 119-1692-00 ..... **$65**
**Extender Board** Order 067-1005-00 ..... **$300**



*Pedestal Configuration: Display shows new 4115P51 feature enhancement which enables efficient implementation of host-based window management functions.*

## 4115B/M4115B

### Computer Display Terminal

**High Performance Color With Unparalleled Resolution and Speed**

**Up to 256 Colors Displayed from a Palette of 16 Million Colors.**

**Autoconvergence**

**Local True Zoom and Pan**

**3-D Wireframe Capability**

**Feature Extensions for Window Management, Segment Subroutines and Editing, and Circular Arcs**

**Compatibility with 4010, 4100, and 4110 Series Hardware and Software**

**The Tektronix 4115B is a High Resolution Computer Display Terminal that Combines High Performance Graphics with Unmatched Display Quality**

With a 32-bit coordinate space and up to 256 simultaneously displayable colors, the 4115B represents the leading edge in color graphics displays. The display controller redraws a high-density mechanical drawing or typical gate array design in less than a second. The 4115B also offers all the powerful local graphics functions of the Tektronix 4110 Series—including local picture segments and true zoom and pan.

**Unsurpassed Display Resolution**

The 4115B's 483 mm (19 in) raster scan display achieves unparalleled line quality with resolution of 1280 x 1024 pixels. Resolution is further refined by a precise contrast ratio, by low reflection, and automatic control of display convergence. A 60 Hz noninterlaced refresh rate also improves display clarity and productivity by greatly reducing flicker and resultant eye fatigue.

**An 8086 CPU and 8087 Coprocessor Team up with a Bipolar Bit Slice Graphics Processor to Yield Singularly Fast Response Times**

The 4115B redraws at 50,000 vectors per second. Panel fill occurs at a rate of 10,000 rectangles per second. Large rectangular areas may be color filled at a rate of 125 million pixels per second.

**Advanced 3-D Wireframe Performance*[1]**

The new 4115F58 3-D Wireframe Kit delivers exceptional value via feature enrichment. The enhancement adds 3-D wireframe capability to the existing 2-D feature set, making possible local 3-D transformations such as rotation, scaling, clipping and skewing. Users can mix 2-D and 3-D information on the screen at the same time ... all with local zoom and pan, including spherical zoom and pan on 3-D wireframe models. 3-D cursors facilitate graphic input and manipulation, and a 24-bit integer terminal space is provided for building 3-D vectors, wireframe panels and polygons.

Parallel and perspective projections enable users to orient their eye position at any angle or distance and view images from the front, rear or side along any axis. The enhancement allows positioning of horizontal text and markers of uniform size, facing the user. This orientation device can save hours when working on complex images.

**Software-Resident Feature Enhancements for Sophisticated Graphics Manipulation and Highly Interactive Applications**

A special enhancement package, the 4115P51, increases productivity by providing a set of four powerful terminal features. The first provides new features to support host window management with pop-up menus and multiple scrolling dialog areas. Small menus can be saved in terminal memory without disturbing on-screen graphics. The terminal's single dialog area is expandable to 64 independently scrolling dialog areas, which allows up to 64 separate host tasks -- graphics or text -- to be simultaneously displayed on the screen. The host controls the programs (such as mail and language compilers) and routes the output to separate dialog areas. The 4115B can be connected to multiple computers (via a communications network), allowing display of information from multiple tasks.

*[1] Available Spring 1985*

Next, the 4115P51 segment subroutine feature allows segments to be stored in a hierarchical structure that more closely corresponds with host program structures. This lets users call segments from within other segments and is useful for local storage of pictures with many repeated elements, such as integrated circuit design.

The third 4115P51 feature gives the 4115B the ability to perform general editing of segments without recreating and retransmitting the entire segment, significantly reducing complexity and editing time.

Finally, the 4115P51 allows the user to define circular arcs by specifying only three points. The terminal automatically connects the points with a series of vectors, making the arc as coarse or smooth as the user wishes. This feature can result in greatly reduced communications traffic.

The 4115P51 enhancements are included in the 4115F58 3-D Wireframe Kit.

**4110 Series/PLOT 10 Compatible**

The 4115B is supported by the Tektronix PLOT 10 IGL (Interactive Graphics Library) and is designed for ease of integration with other 4110 Series terminals.

The 4115B Option 09 provides plug-compatibility with the Tektronix 4691 and 4692 Color Graphics Copiers.

Option 19 provides 4695 Color Graphics Copier plug-compatibility.

The 4115B can be configured either as a pedestal unit or in separate display, processing, and keyboard modules (M4115B) for workstation configurations. Local memory can be expanded to 800 kbytes and mass storage is available in combinations of single or dual flexible and Winchester disks.

### CHARACTERISTICS

**DATA TRANSMISSION**

**Data Rate** — 19.2 kbaud.

**Communications Interface** — RS-232C.

**MEMORY**

**Standard** — 288 kbytes, expandable to 800 kbytes.

**DISPLAY**

**Medium** — Color raster.

**Size** — 483 mm (19 in) diagonal.

**Refresh Rate** — 60 Hz, noninterlaced.

**Convergence** — Automatic

**KEYBOARD**

**Normal Keyboard** — 72 typewriter paired upper and lower case, programmable and autorepeating.

**User Definable Programmable Function Keys** — Eight.

**Terminal Control Keys** — Four.

**Zoom and Pan Keys** — Four.

**Graphic Cursor Control** — Thumbwheels.

**GRAPHICS MODE**

**Addressability** — Four billion x four billion.

**Resolution** — 1280 x 1024 pixels.

**Graphic Command Syntax** — PLOT 10 compatible, 4010, 4100 and 4110 Series compatible.

**Colors** — 16 standard, expandable to 256.

**Palette Selection** — 16 million.

**ALPHANUMERIC MODE**

**Character Set** — 94 (full ASCII).

**Character Format** — 80 columns, 34 rows and 160 columns, 64 rows.

*Modular Configuration (furniture not included). Display shows new 4115F58 enhancement which provides the 4115B with 3-D wireframe capability in addition to its current 2-D feature set.*

### AC POWER

**Line Voltage** — 115 V, 230 V RMS.

**Line Frequency** — 48 Hz to 66 Hz.

**Power** — 1400 W.

### PHYSICAL CHARACTERISTICS

| Dimensions | Module | | Pedestal | |
|---|---|---|---|---|
| | mm | in | mm | in |
| Width | 432 | 17.0 | 610 | 24.0 |
| Height | 622 | 24.5 | 876 | 34.5 |
| Depth | 762 | 30.0 | 787 | 31.0 |
| **Weight** | **kg** | **lb** | **kg** | **lb** |
| Net | 65.0 | 140.0 | 75.0 | 165.0 |

### PHYSICAL CHARACTERISTICS

| Dimensions | Display | | Keyboard | |
|---|---|---|---|---|
| | mm | in | mm | in |
| Width | 584 | 23.0 | 508 | 20.0 |
| Height | 406 | 16.0 | 43 | 1.7 |
| Depth | 559 | 22.0 | 203 | 8.0 |
| **Weight** | **kg** | **lb** | **kg** | **lb** |
| Net | 55.0 | 120.0 | 2.5 | 5.0 |

### INCLUDED ACCESSORIES

Two 8 ft power cables (161-0123-00); 12 ft host port RS-232 cable (012-0911-00); three 4115B BNC cables (012-0074-00); 4115B display assembly to pedestal cable (012-0525-00); pkg of six function key overlays (334-3290-02); operator's manual; 4110 series host programmer's manual; 4110 series command reference manual; 4110 series command reference guide; introduction brochure. M4115B also includes: Three 10 ft BNC cables, (175-2753-00); 10 ft display assembly to pedestal cable (012-0387-00).

## ORDERING INFORMATION

**4115B** Computer Display Terminal ... **$22,950**

**M4115B** Computer Display Terminal Workstation ..... **$22,950**

**Option 01** — Extended Communications Interface .. **+$1,000**
**Option 2A** — Additional 256 kbytes RAM with ECC ..... **+$2,500**
**Option 2B** — Additional 512 kbytes RAM with ECC ..... **+$5,000**
**Option 3A** — DMA Interface for DEC VAX Unibus; Requires Option 3B or Modified Cable ..... **+$4,600**
**Option 3B** — 30 ft Cable for Option 3A; Must be Ordered Separately ..... **+$250**
**Option 4A** — United Kingdom Keyboard ..... **+$175**
**Option 4C** — Swedish Keyboard ..... **+$175**
**Option 4F** — Danish/Norwegian Keyboard ..... **+$175**
**Option 4K** — Japanese (Katakana) Keyboard ..... **+$175**
**Option 09** — 4691/4692 Color Copier Interface ..... **+$700**
**Option 10** — Three-port Peripheral Interface ..... **+$1,350**
**Option 14** — Graphic Tablet, 30 in x 40 in, with Controller ..... **+$4,950**
**Option 19** — 4695 Color Copier Interface ..... **+$700**
**Option 22** — Additional Two Planes Display Memory ..... **+$3,300**
**Option 23** — Additional Four Planes Display Memory ..... **+$6,600**
**Option 42** — Single Flexible Disk with Controller .... **+$2,000**
**Option 43** — Dual Flexible Disk with Controller ..... **+$2,800**
**Option 45** — Mass Storage Interface ..... **+$1,500**
**Option 46** — 10 MB Hard Disk (For M4115B only) . **+$2,600**
**Option 47** — Dual 10 Mbyte Hard Disks (For M4115B only) ..... **+$4,100**

### ENHANCEMENTS

**4115P51** Feature Extension (Requires Option) ..... **$1,000**

**Option 01** — 9-Track, EBCDIC, Standard Label, Block 10 x 80, 1600 BPI ..... **NC**
**Option 02** — Eight inch Flexible Disk, 4110 Format ..... **NC**
**Option 03** — 9-Track, PDP-11 DOS, ASCII, 800 BPI ..... **NC**
**Option 04** — 9-Track, PDP-11 DOS, ASCII, 1600 BPI .... **NC**
**Option 05** — 9-Track, EBCDIC, No Label, Block 10 x 80, 1600 BPI ..... **NC**
**Option 08** — 9-Track, IBM ASCII, No Label, 1600 BPI ..... **NC**

**4115F58** 3-D Wireframe Kit (Requires Option 01) ..... **$100**

**Option 01** — (For 4115/M4115B Only) ..... **+$5,900**

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLANS REFER TO PAGE 14**

**N1** — Service Plan + 9 Months Service ..... **+$1,025**
**N3** — OEM Service Plan + 12 Months Service ..... **$1,370**

### OPTIONAL ACCESSORIES

**Service Manual Vol I** — 070-4666-00.

**Service Manual Vol II** — 070-4667-00.

**Display Service Manual** — 070-4668-01.

**Loop Connector for Host-Port Test (RS-232)** — Order 067-1043-00 ..... **$17**

**411X Logic Extender Board** — Order 067-1005-00 ..... **$300**

**Raster Bus Extender Board** — Order 067-1173-00 ..... **$125**

**Media, Flexible Disk (Pkg of 10)** — Order 119-1376-01 . **$110**

**Calibration Graticule, Display** — Order 067-1142-00 .. **$235**

**Convergence Checker RCA Type 507R** — Order 067-1164-00 ..... **$470**

### M4115B OPTIONAL ACCESSORIES

Optional accessories for the M4115B are the same as those for the 4115B except for the following:

**Display Stand, (Tilts, Swivels, Stands on Floor)** — Order 016-0717-01 ..... **$750**

**Ergonomic Chair** — Order 016-0698-00 ..... **$600**

**Workstation Table** — Order 016-0791-00 ..... **$1,795**

### COMPANION PRODUCTS

**4691** — Color Graphics Copier ..... **$12,950**
**4692** — Color Graphics Copier ..... **$5,995**
**4695** — Color Graphics Copier ..... **$1,595**
**4510** — Color Graphics Rasterizer ..... **$3,500**
**4634** — Hard Copy Unit ..... **$7,900**
**4926** — Hard Disk ..... **$4,200**

See this color product in the reference section beginning on page 17.

## 4114B/4114B30
### Computer Display Terminal

**Direct View Storage Tube with Local Picture Segments**

**2-D Transforms, Refresh Support and Fast Redraw**

**Compatible with Tektronix 4010, 4100 and 4110 Series Terminals**

**The 4114B Computer Display Terminal Satisfies the Needs of Graphics Users for Faster, More Versatile Throughput in High Density Graphics Applications.**
Its local intelligence and expandable memory can significantly reduce the delays and costs associated with over-dependence on a host computer. The 4114B has a resolution high enough for the most complex engineering and scientific graphics. The upgraded "B" Series provides for our Local Programmability capability. Earlier 4114 or 4114A terminals can easily be field upgraded to 4114B.

Direct local access to all 4114B features under program control is provided by the addition of either the 4100P01 or 4100P02 Local Programmability products.

**The 4114B is Compatible with Tektronix 4010, 4100 and 4110 Series Computer Display Terminals.**
Using the modular device drivers and advanced feature support of Tektronix PLOT 10 IGL (Interactive Graphics Library) makes updating existing programs a simple process.

The 4114B supports local picture segments which are a group of graphic primitives describing a portion of a picture, retained as a unit in local memory to be redrawn or manipulated at any time. Schematic components, symbols, titles, and text can be defined as segments, then stored and recalled easily. Local segments can be rotated, scaled or moved around the screen, with only a simple command from the host or a local program.

**Refresh Support**
Local generation of more than 1500 cm or approximately 3000 short vectors of flicker-free refresh. Option 31 provides color enhanced (amber) refresh for easy recognition of refresh information.

## 4114B30 Workstation

Computer display terminal operators can improve their performance with the efficiency, convenience and comfort of the 4114B30, modular workstation.

The pedestal module contains the power supply and circuit board cage, and also houses one or two optional flexible disk drives for convenient local storage. Supporting the display at eye level, the table module can be installed on the left or the right side of the pedestal. The keyboard for the 4114B30 can be detached from the table module for positioning in the lap, on the pedestal, or underneath the display screen.

## CHARACTERISTICS

**DATA TRANSMISSION**

**Data Rate** — 50 b/s to 19,200 b/s.
**Data Type** — 7-bit asynchronous serial ASCII, plus parity bit.
**Block Mode** — Option 01 Extended Communications.
**Communications Interface** — RS-232C.

**DISPLAY**

**Medium** — Direct view storage tube; 4096 x 4096 addressable points; 4096 x 3120 displayable points; enhanced refresh; fast redraw.
**Dimensions** — 368 mm x 277 mm (14.5 in x 10.9 in); 483 mm (19 in) diagonal.

**MEMORY**

**Standard** — 56 kbytes ROM and 288 kbytes RAM (expandable to 800 k).

**KEYBOARD**

**Normal Keyboard** — 72 typewriter paired, upper and lower case, programmable and auto repeating, (five lighted). User Definable Programmable Function.
**User Definable Programmable Function Keys** — Eight.
**Graphic Cursor Control** — Thumbwheels.
**Alpha Cursor Position** — Key control.
**Scrolling** — Thumbwheels.

**GRAPHICS MODE**

**Addressability** — 4096 x 4096.
**Line Types** — Solid dashed, defocused.
**Drawing Speed (Storage)** — 134 m/s.
**Drawing Speed (Refresh)** — 537 m/s.
**Graphic Command Syntax** — Tektronix PLOT 10 compatible.

**ALPHANUMERIC MODE**

**Standard Displayable Character Set** — 94 characters (full ASCII).

**AC POWER**

90 V ac to 132 V ac, 11 A maximum or 180 V ac to 250 V ac, 5.5 A maximum, 48 Hz to 62 Hz.

**PHYSICAL CHARACTERISTICS (4114B)**

| Dimensions | mm | in |
|---|---|---|
| Width | 597 | 23.5 |
| Height | 1290 | 51.0 |
| Depth | 813 | 32.0 |
| **Weight** | **kg** | **lb** |
| Net | 107.5 | 237.0 |

**PHYSICAL CHARACTERISTICS (4114B30)**

**Monitor Height** — 425 mm (16.8 in).
**Width:** 584 mm (23.0 in).
**Depth:** 582 mm (22.9 in).
**Pedestal Height** — 743 mm to 762 mm (29 in to 30 in).
**Width:** 565 mm (22.3 in).
**Depth:** 851 mm (33.5 in).
**Keyboard Height** — 38 mm to 70 mm (1.5 in to 2.8 in).
**Width:** 508 mm (20.0 in).
**Depth:** 229 mm (9.0 in).
**Table Height** — 673 mm to 692 mm (26.5 in to 27.2 in).
**Width:** 1219 mm (48.0 in).
**Depth:** 762 mm (30.0 in).
**Total Weight** — 165.9 kg (365.7 lb).

**INCLUDED ACCESSORIES 4114B/4114B30**

8 ft power cord (161-0123-00); 21 in pedestal to display power cable (161-0145-00); 12 ft host port RS-232 cable (012-0911-00); pkg of eight re-legendable key caps (366-1882-00); pkg of six function key overlays (334-3290-01); 4114B/4116B operator's manual; 4114B/4116B host programmer's manual; 4110B Series command reference; 4114B/4116B introduction brochure.
**All accessories for the 4114B30 are the same as those for the 4114B, except for the following:**
Display swivel/tilt base (016-0467-01); pedestal to display power cable (161-0126-00); 4110B30 Series desk configuration service manual.

## ORDERING INFORMATION

**4114B** Computer Display Terminal ... **$17,900**
**4114B30** Computer Display Terminal Workstation ..... **$19,400**
**Option 01** — Extended Communications ..... **+$1,000**
**Option 10** — Three - Port Peripheral Interface ..... **+$1,350**
**Option 14** — 30 x 40 in Graphic Tablet w/Pen ..... **+$4,950**
**Option 2A** — Adds 256 Kbytes of RAM ..... **+$2,500**
**Option 2B** — Adds 512 Kbytes of RAM ..... **+$5,000**
**Option 31** — Color Enhanced Refresh ..... **+$1,000**
**Option 32** — Table Module (4114B30 only) ..... **+$500**
**Option 4A** — United Kingdom Keyboard ..... **+$175**
**Option 4C** — Swedish Keyboard ..... **+$175**
**Option 4E** — APL Keyboard ..... **+$850**
**Option 4F** — Danish/Norwegian Keyboard ..... **+$175**
**Option 4K** — Japanese (Katakana) Keyboard ..... **+$175**
**Option 41** — Ten-Slot Peripheral Bus Extender; 90-110 line voltage ..... **NC**
**Option 42** — Single Flexible Disk and Disk Controller ..... **+$2,000**
**Option 43** — Dual Flexible Disk and Disk Controller . **+$2,800**
**Option 45** — Mass Storage Interface ..... **+$1,500**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS*** **SERVICE PLANS REFER TO PAGE 14**

**N1** — Service Plan + 9 Months Service ..... **+$810**
**N3** — OEM Service Plan + 12 Months Service ..... **$1,080**

**OPTIONAL ACCESSORIES**

**Ergonomic Chair** — Order 016-0698-00 ..... **$600**
**Display Stand** — Order 016-0717-01 ..... **$750**

See the color enhanced refresh option in the reference section beginning on page 17.

OEM terms available on this product.

NEW

ARTIFICIAL INTELLIGENCE

## 4404 Artificial Intelligence System

**Low-Cost, High-Performance AI Development System**

**32-Bit CPU, Virtual Memory**

**Smalltalk-80 Programming Environment**

**Bit-Mapped Graphics with Mouse Input**

**ANSI X3.64 Terminal Emulation**

**Franz LISP and Prolog Languages Available as Options**

**The Tektronix 4404 Artificial Intelligence System Provides a Powerful, Highly Interactive Environment for AI Research and Development at an Affordable Price.**

Combining 32-bit processing power with the Smalltalk-80 programming language, virtual memory and a bit-mapped graphics user interface, the 4404 sets a new price/performance standard for AI development systems in applications such as expert systems, natural languages, intelligent robotics and automatic programming.

The object-oriented Smalltalk-80 language was designed expressly for exploratory programming. Tek's proprietary implementation of Smalltalk-80, combined with the 4404's display capabilities, achieves execution speeds that are exceeded only by far costlier systems. The 4404 also offers the LISP and Prolog languages as programming options.

### Powerful Bit-Mapped Graphics and Mouse Input

A bit-mapped graphics display with mouse input is closely coupled to the processor for a state-of-the-art user interface. The 13-inch monochrome display has 640 x 480 pixel resolution operating with 60 Hz noninterlaced refresh. It functions as a window into a 1024 x 1240 bit-map memory. The bit-mapped display facilitates the 4404's window management, pop-up menus and mouse manipulation. Highly responsive graphics make screen animation possible.

### High Performance Through Thoughtful Design

The 4404 uses a multi-tasking operating system with a hierarchical file system and virtual memory support. The user has an 8 Mbyte virtual address space for program development and both a 40 Mbyte hard disk and a 5 1/4-inch floppy disk for storage of large programs and data bases. Although the 4404 is an independent development environment, it can emulate a host-based terminal through an RS-232 port. It can also be used in a local area network through an optional Ethernet interface. The 4404 is easily expandable through the addition of an optional 40 Mbyte hard disk with streaming tape backup, and an additional 1 Mbyte of physical memory.

### 4404 CHARACTERISTICS

**DATA TRANSMISSION**

**Interface Ports** — RS-232C.

**Data Rate** — 9600 baud (with flagging).

**DISPLAY**

**Medium** — Monochrome Raster CRT.

**Size** — 330 mm (13 in).

**Viewing Area** — 241 mm x 178 mm (9.5 in x 7 in).

**Refresh Rate** — 60 Hz, noninterlaced.

**Bit-Map Resolution** — 640 points x 480 points.

**Addressable Points** — 1024 x 1024.

**Input Devices** — Joydisk, mouse.

**STORAGE**

**Hard Disk** — 40.8 Mbyte (formatted).

**Flexible Disk** — 320 kbyte (formatted).

**AC POWER**

**Line Voltage** — 115 V (nominal), 87 V to 128 V, 230 V (nominal), 174 V to 250 V.

**Line Frequency** — 48 Hz to 66 Hz.

**Power** — <200 W operating.

**PHYSICAL CHARACTERISTICS**

| Dimensions | Terminal | | Keyboard | | Mass Storage | |
|---|---|---|---|---|---|---|
| | mm | in | mm | in | mm | in |
| Width | 419 | 16.5 | 423 | 16.7 | 368 | 14.5 |
| Height | 353 | 13.9 | 41 | 1.6 | 128 | 5.0 |
| Depth | 995 | 19.5 | 180 | 7.1 | 433 | 17.0 |
| **Weights** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** |
| Net | 20.0 | 44.0 | 11.0 | 5.0 | 6.4 | 14.0 |

**MASS STORAGE (OPTION 20)**

**PERFORMANCE**

**Capacity** — 40.8 Mbyte (formatted).

**Access Time** — 30 ms (average), 6 ms (track-to-track).

**Average Latency** — 8.3 ms.

**Data Transfer Rate** — 100 kbyte/s maximum burst rate.

**Error Rates** — Nonrecoverable (hard) 1 in $10^{12}$ bits.

**Interface Ports** — SCSI described in ANSI document X3T9.2/82.2.

**Power** — 140 W.

**INCLUDED ACCESSORIES (4404)**

Power cord (161-0066-00); standard keyboard (119-1872-00); RS-232C cable (012-0911-00); SCSI terminator (011-0090-00); users manual, reference manual, Introduction to Smalltalk.

**INCLUDED ACCESSORIES (OPTION 20)**

Power cord (161-0066-00); SCSI cable (012-0037-00); instruction manual.

### ORDERING INFORMATION

**4404** Artificial Intelligence System .... **$14,950**

**Option 01** — Additional 1 Mb Memory ..... **+$5,000**
**Option 10** — Ethernet Interface ..... **+$2,000**
**Option 20 or 4404F20** — 40 Mb Hard Disk with Tape Streamer for Backup ..... **+$6,500**
**4400P30** — Franz LISP Programming Language ..... **$4,000**
**Option 02** — 5 1/4 in Floppy Media; 4400P31 Prolog Programming Language ..... **NC**
**4400P31** — Prolog EMACS Editor ..... **$4,000**
**Option 02** —5 1/4-inch floppy Media ..... **NC**
**4400P32** — EMACS Editor ..... **$500**
**Option 02** — 5 1/4 in Floppy Media ..... **NC**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 115 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/6 A, 50 Hz

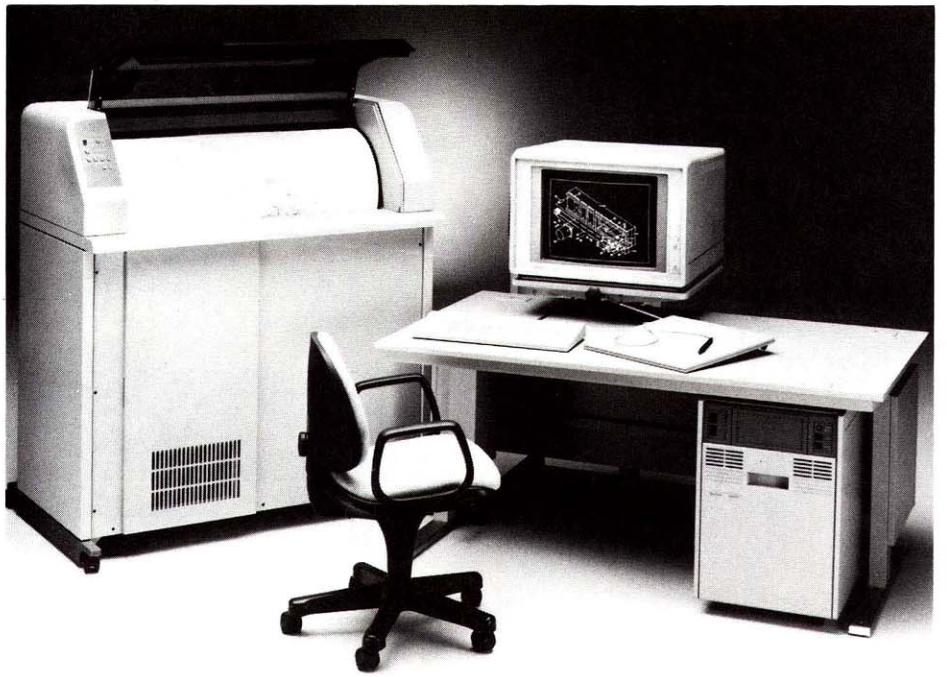
***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 14**

**N0** — Installation and Setup ..... **$175**
**N1** — Service Plan + 9 Months Service ..... **+$560**
**N3** — OEM Service Plan + 12 Months Service ..... **+$740**

*Smalltalk-80 is a trademark of Xerox Corporation.*

**Initially available within the U.S. only. Contact your nearest Sales Office for availability in your area.**

OEM terms available on this product.



## 4991S1 Graphic Input Workstation

**Cost-Effective Means of Inputting Vast Amounts of Graphical Data into Computer Databases**

**Automatically Scans and Vectorizes Documents Up to 35 Inches x 47 Inches (E-Size)**

**Produces Lines, Arcs, Text, Symbols and Layers Through Interactive Software**

**Inserts Data Directly into Data Bases of Popular CAD Systems**

**The Tektronix 4991S1 Graphic Input Workstation is a CAD Database Creation Tool Designed to Increase Productivity Over Redesign on the Screen or Manual Digitizing**
The 4991S1 transforms existing drawings — on paper, Mylar or other media — into vector data for storage in CAD databases. You can design new products on your CAD system using existing drawings as points of departure. Time-consuming, tedious manual digitization is eliminated.

The 4991S1 consists of a Tektronix 4991 Autovectorizer, an M4115B Computer Display Terminal, a 4957 Graphics Tablet, and special Graphics Structuring and Host Interfacing Software.

**Local Scanning, Vectorizing and Structuring of Data**
Scanning and structuring of data are performed locally, preserving CAD system resources. First, the 4991 Autovectorizer scans the source document and converts it into a computer-based list of vector data. Second, the data is interactively structured on the M4115B with the aid of proprietary Graphics Structuring Software. User-selectable structuring features include semi-automatic arc, line, text and symbol replacement; N-point registration; snap-to-grid; and line-straightening. Alphanumeric tags can be assigned to features (e.g., information on color, year built, etc.) Also, the user can directly select specific portions of the drawing and store them in separate layers.

Third, the Host Interfacing Software resident on the host computer accepts data from the 4991S1 and stores it in a form acceptable to the host CAD system using CAD system calls.

The 4991S1 supports many popular CAD systems on the market and may be interfaced to a variety of others through user-customized Host Interfacing Software.

### 4991 AUTOVECTORIZER CHARACTERISTICS

**Scanning Technology** — High-precision drum scanner with halogen lamp illumination and linear photodiode detection.
**Maximum Scan Area** — 885 mm x 1200 mm (34.84 inch x 47.24 inch).
**Resolution** — 12 samples per mm (304.8 samples per inch).
**Typical Media** — Black graphic lead or black ink on vellum. Black plastic lead or black ink on drafting film. Photographics artwork. High contrast bluelines (contrast ⩾.5).
**Minimum Line Detected** — 0.254 mm (contrast ⩾.5).
**Programmable Features** — User-definable: scan area, dot and void removal, edge-smoothing, line-gap filling, digitizing threshold, line-fitting accuracy.

#### COMMUNICATIONS CAPABILITIES

**Hardware** — RS-232C, 19.2 kbaud.
**Protocol** — "KERMIT-type"*1.
**Modes** — Freeman code data, polynode data, interconnect data, combined data.

#### AC POWER

**Line Voltage** — 87 V to 128 V, 174 V to 250 V.
**Line Frequency** — 48 Hz to 62 Hz.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 1219 | 48 |
| Height | 1283 | 51 |
| Depth | 787 | 31 |
| **Weights** | **kg** | **lb** |
| Net | 150 | 330 |

*1 *KERMIT is a product of Columbia University Center for Computing Activities*

### M4115B WORKSTATION CHARACTERISTICS

#### MEMORY

**Standard** — 2.0 Mbytes RAM with ECC, 20 Mbytes internal hard disk.
**Note: For all other M4115B product specifications, refer to page 60.**

#### GRAPHIC STRUCTURING SOFTWARE

**Interaction** — Menu-driven system using tablet interface.
**Structuring Capabilities** — Graphical Primitives Supported: Lines, polylines, polygons, arcs, circles, text, symbols, ellipses, arrows, dimensions. Attributes Supported: Layer number, pen number, color, line width and style, text font, character slant, user definable attributes.
**Transformation Operations** — N-point alignment, snap-to-grid, reflection.
**Viewing Capabilities** — Zoom, pan, previous view, original view.
**Local Calculations** — Position, distance.
**Host Control and Interfacing Capabilities** — Protocol —"KERMIT-type" communications.
**Training Tutorial** — Built-in.
**Performance** — Capacity, 98,000 nodes. Larger drawings are managed by structuring smaller sections of original file.

#### PHYSICAL CHARACTERISTICS

**Media** — Eight inch floppy disks.

#### HOST INTERFACING SOFTWARE

**Data Communications** — "KERMIT-type" protocol.
**Data Conversion** — 4991S1 to IBM CADAM, Version 19 (MVS). 4991S1 to Computervision CADDS4X. 4991S1 to Tektronix PLOT 10 Computer-Aided Drafting (TekniCAD). Other conversions planned.
**Data Checking** — Unrecognized or illegal host system commands or data displayed on 4991S1 display for immediate correction.
**Configuration** — Host system resident.
**Language** — FORTRAN IV.

#### PHYSICAL CHARACTERISTICS

**Media** — Nine-track mag tape, 1600 BPI.
**Format** — Block 80 x 10, either standard label EBCDIC or unlabelled ASCII.

#### INCLUDED ACCESSORIES

Workstation table (016-0791-00); spare lamp; DC 100 program load tapes; power line cord; communications cable; drum cleaner; 4991S1 Operator's Manual, Reference Manual.

### ORDERING INFORMATION

**4991S1** Graphic Input Workstation **$150,000**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option AI** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz
***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 14**
**N1** — Service Plan + 9 Months Service ..... **+$445**
**N3** — OEM Service Plan +12 Months Service ..... **+$5,930**

#### OPTIONAL ACCESSORIES

**Board-Level Diagnostics Tape** — Order 062-7779-00.*1
**Replacement Lamps** — Order 150-0142-00.*1
**Replacement Program Load Tape** — Order 062-7778-00.*1
**Ergonomic Chair** — Order 016-0698-00 ..... **$600**
**4110 Display Stand** — Order 016-0717-01 ..... **$750**
**Service Manual.**
*1 *Contact your local sales representative.*

**Initially available within the U.S. only. Contact your nearest Sales Office for availability in your area.**



OEM terms available on this product.

## 4691 Color Graphics Copier

**High Image Quality and Excellent Color Saturation**

**Adjustable for A and B Size**

**Landscape and Portrait Formats**

**Clear Transparency Capability**

**Four-Way Multiplexer Option**

**125 Color Patterns from Local Programmability**

**256 Color Patterns from New Enhanced 4110 Series Option 09**

**The 4691 Color Graphics Copier Provides High Performance Color Copying from the 4113B, 4115B/M4115B Computer Display Terminals and Other Raster Data Sources**

Copies can be made in A size (8.5 in x 11 in) or B size (11 in x 17 in) and their metric equivalents, in as little as two to three and a half minutes. The high performance drop-on-demand ink-jet technology provides addressability of six dots per mm (150 dots per inch) in both horizontal and vertical directions. This allows up to 1560 x 2460 points in a B size image, and up to 1560 x 1200 points in an A size image. Full resolution B-size copies are particularly suited for complex engineering drawings. For best B-size quality, it is recommended the 4691 be used with the NEW 4510 Color Graphics Rasterizer. (See page 67 for details). The 4691 produces true black by using a separate black ink supply, superior to that obtained by mixing the three primary inks. Vivid overhead transparencies can also be produced.

Copies are generated by program command, or by pushing a button on the Tektronix 4113B or 4115B terminal keyboard. Image orientation and multiple copies of the same image can be controlled through program control.

### Flexible Configuration

The 4691 uses a Centronics-type parallel interface, with modifications from the basic standard to support color, four-channel multiplexing and faster data transfer. With four-channel multiplexing (Option 02), the 4691 can serve up to four data sources at once.

The 4691 copies color shading patterns that are produced by the data source, including the 125 callable shading patterns supported by Local Programmability and the 256 color patterns produced by the new enhanced 4110 Series, Option 09 firmware.

When supported by a host driving routine and rasterizing software, the 4691 is compatible with many systems offering a Centronics-style parallel output port.

### CHARACTERISTICS

**Addressability** — Vertical and Horizontal: 6 dots/mm (150 dots/in).

**Copy Time** — 2.0 to 3.5 minutes minimum. Copy times may be longer if data transfer from image source is not maintained at 18 KB.

**Page and Image Format** — B and A, or A3 and A4 Output Sizes. Landscape and Portrait Format selectable under program control. Pixel replication is used for B and A3 images.

**Image Sizes** — Variable depending on page size and image source.

**Colors** — Eight (magenta, yellow, cyan, red, green, blue, black, white).

**Media Types** — Paper sheet, overhead transparency.

**Compatibility** — 4113B Option 09 and 4115B/M4115B Option 09. Order 4110F09 and level three firmware to upgrade an existing 4113 for compatibility.

**Interface** — Eight bit parallel.

**Data Rate** — Up to 400 kbytes/s (burst mode).

#### AC POWER

**Line Voltage** — 90 V ac to 110 V ac, 105 V ac to 129 V ac, 180 V ac to 220 V ac, or 211 V ac to 258 V ac, all at 48 Hz to 62 Hz.

**Input Power** — 500 W operating.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 608 | 23.9 |
| Height | 346 | 13.6 |
| Depth | 821 | 32.3 |
| **Weight** | **kg** | **lb** |
| Net | 60.0 | 132.0 |

#### INCLUDED ACCESSORIES

500 sheets (B size and A3 size when Opt 01 is ordered) ink jet copy paper (016-0711-00); 200 ml capacity each ink jet cartridges, cyan (016-0713-00); black (016-0714-00); yellow (016-0715-00); magenta (016-0716-00); 10 ft interconnecting cable 3 meters (012-0518-00); power cable (161-0104-00); "A" and "B" Size (Standard) paper tray (118-2557-00); "A3" and "A4" Size (if Option 01 is ordered) paper tray (118-2556-00); 3/pkg drum adaptors (118-2593-00); operator's manual, operator's guide.

### ORDERING INFORMATION

**4691** Color Graphics Copier ..... **$12,950**

When purchased with 4115B/M4115B ..... **$9,950**

**Option 01** — Setup for A3 Size Output ..... **NC**

**Option 02** — Four Channel Multiplexer ..... **+$1,200**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

**Option A5** — Switzerland 220 V/10 A, 50 Hz

#### *WARRANTY PLUS* SERVICE PLANS REFER TO PAGE 14

**N0** — Installation and Set-Up ..... **NC**

**N1** — Service Plan +9 Months Service ..... **+$900**

**N3** — OEM Service Plan +12 Months Service ..... **+$1,200**

#### OPTIONAL ACCESSORIES

**Service Manual**

**Device Driver Development Guide**

**Test Fixture** — Order 067-1158-00 ..... **$250**

**Interconnect Cable** — Nine meter (29.9 ft). Order 012-0527-00 ..... **$165**

**Ink Jet Copy Paper** — "A" Size, 216 x 279 mm (8.5 in x 11 in) (500 sheets/pkg). Order 016-0712-00 ..... **$25**

**"B" Size** — 279 x 432 mm (11 in x 17 in). Order 016-0711-00 ..... **$40**

**"A4" Size** — 297 x 210 mm (For use w/Opt 01 only). Order 016-0709-00 ..... **$20**

**"A3" Size** — 297 x 420 mm (For use w/Opt 01 only). Order 016-0710-00 ..... **$35**

**Transparency Film** — "A" Size 100 sheets/pkg. Order 016-0765-00 ..... **$85**

**Transparency Kit** — "A" Size (Field Retrofit). Order 020-1161-00 ..... **$200**

**"A4" Size** — Order 020-1162-00 ..... **$200**

**Ink Jet Cartridges** — (200 cc) See included accessories.

Cyan: Order 016-0713-00 ..... **$85**

Black: Order 016-0714-00 ..... **$85**

Yellow: Order 016-0715-00 ..... **$85**

Magenta: Order 016-0716-00 ..... **$85**

**Drum Adaptors** — 3/pkg. Order 118-2593-00 ..... **$15**

#### COMPANION PRODUCT

**4510 Rasterizer** — Supports the full resolution of the 4691 while expanding the color palette to over 132,000 colors and shades. Allows 4691 to be a shared system resource. See page 67 ..... **$3,500**

See this color product in the reference section beginning on page 17.

NEW

COLOR GRAPHICS COPIER

## 4692 Color Graphics Copier

**Superior Image Quality and Excellent Color Saturation**

**Unique Ink Transient Suppressor for Reliable Operation**

**Adjustable for A and A4 Size**

**Horizontal and Vertical Formats**

**Four-Channel Multiplexer I/F Option**

**Variable Image Density and Copy Time**

**216 On-board Colors**

**Auto-Handling of Paper and Transparencies**

**The new Tek 4692 Color Graphics Copier Offers High-Quality A and A4-size Color Copying from 4100 and 4110 Series Color Display Terminals or from a Host with the Tek 4510 Color Graphics Rasterizer**

The 4692 represents a new standard in color ink-jet reliability. The high performance drop-on-demand air flow technology provides addressability of up to 154 dots per inch (6 dots per mm) in both horizontal and vertical directions. This allows up to 1536 by 1152 dots in an A-size image. Specially matched paper and transparency media and inks provide highly saturated colors (including vivid black due to a separate black ink supply).

Each ink-jet head is backed by a unique Ink Transient Suppressor (patent pending) that effectively prevents the ink clogs and bubbles associated with some ink-jet printers.

### Color Copies With Ease

Copies can be made in as little as one minute by pushing a single button. Image orientation, image density and color (from 216 on-board colors) can be selected. Up to 50 sheets of paper or 25 transparencies are fed, processed and stacked automatically in the output tray. Individual snap-in easily replaceable ink cartridges provide approximately 4,000 copies.

### Flexible Configuration

The 4692's 8-bit parallel interface is compatible with the 4106, 4107, 4109, 4113B Option 09, and 4115B Option 09 Computer Display Terminals. With four-channel multiplexing (Option 02), the 4692 can serve any four of these terminals at once. The 4692 also functions as a host-connected shared-system resource, particularly when paired with the 4510 Color Graphics Rasterizer. An optional device driver development manual is available to assist OEMs or end users incorporating the 4692 into their system.

### CHARACTERISTICS

**Addressability** — Fixed mode vertical and horizontal: 6 dots/mm (154 dots/in). Variable "preview" mode vertical and horizontal 128 dots/in to 158 dots/in.

**Copy Time** — 1.0 minutes to 3.0 minutes (depending on image format, addressability mode, and the signal source).

**Page and Image Format** — A and A4 output sizes. Landscape and portrait format selectable under program control.

**Image Sizes** — Variable depending on orientation and image source. (For A-size output; A4-size output slightly smaller to maintain adequate margins).
4106/4107/4109/4113B: Landscape is 10 in x 7.5 in. Portrait is 5 in by 3.75 in. 4115B: Landscape is 9.4 in x 7.5 in. Portrait is not available. 4510: Landscape is 10 in x 7.5 in. Portrait is 7.5 in x 5.6 in.

**Colors** — 216 on-board colors and shades.

**Media Types** — Paper sheet, overhead transparency.

**Compatibility** — 4106, 4107, 4109, 4113B Option 09 and 4115B Option 09 Computer Display Terminals, 4510 Color Graphics Rasterizer.

**Interface** — Eight-bit parallel.

**Data Rate** — Up to 400 kbytes (burst mode).

#### AC POWER

**Line Voltage** — 87 V ac to 107 V ac, 104 V ac to 128 V ac, 191 V ac to 235 V ac, 209 V ac to 250 V ac, all at 48 Hz to 62 Hz.

**Input Power** — 35 W idle, 110 W printing, 360 W peak.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 610 | 24.0 |
| Height | 216 | 8.5 |
| Depth | 610 | 24.0 |
| **Weight** | **kg** | **lb** |
| Net | 32.0 | 70.0 |

#### INCLUDED ACCESSORIES

Power cord (161-0066-00); Size "A"-"A4" input media tray (436-0172-01); output media tray (436-0189-00) operator's manual (070-4816-00);

### ORDERING INFORMATION

**4692** Color Graphics Copier ..... **$5,995**
**Option 01** — Setup for A4 Size Media ..... **NC**
**Option 02** — Four-Channel Multiplexer ..... **+$895**
**Option 03** — Supplies Startup Kit (A-Size Media) ..... **+$300**
**Option 04** — Supplies Startup Kit (A4-Size Media) ... **+$300**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

***WARRANTY PLUS*** **SERVICE PLANS** **REFER TO PAGE 14**
**N1** — Service Plan +9 Months Service ..... **+$555**
**N3** — OEM Service Plan +12 Months Service ..... **+$740**

#### OPTIONAL ACCESSORIES

**Interconnect Cable** — 3 Meter (10 ft). Order 012-0518-00 ..... **$130**
**Interconnect Cable** — 10 Meter (30 ft). Order 012-0527-00 ..... **$165**
**Ink Jet Copy Paper** — 500 sheets/pkg. "A" Size. 216 mm x 279 mm (8.5 in x 11 in). Order 016-0793-00 ..... **$35**
**"A4" Size** — 500 sheets/pkg. 297 mm x 210 mm (For use w/Option 01 only). Order 016-0794-00 ..... **$35**
**Transparency Film** — 100 sheets/pkg. "A" Size. 216 mm x 279 mm (8.5 in x 11 in). Order 016-0765-02 ..... **$90**
**"A4" Size** — 100 sheets/pkg. 210 mm x 297 mm (For use w/Option 01 only). Order 016-0766-02 ..... **$90**
**Ink Jet Cartridges** — 200 cc each
Cyan: Order 016-0713-00 ..... **$85**
Black: Order 016-0714-00 ..... **$85**
Yellow: Order 016-0715-00 ..... **$85**
Magenta: Order 016-0716-00 ..... **$85**
**Maintenance Liquid Cartridge** — Order 016-0770-00 ... **$12**
**Service Manual** — Order 070-4815-00 ..... **$150**
**Device Driver Development Manual** — Order 070-4818-00 ..... **$50**

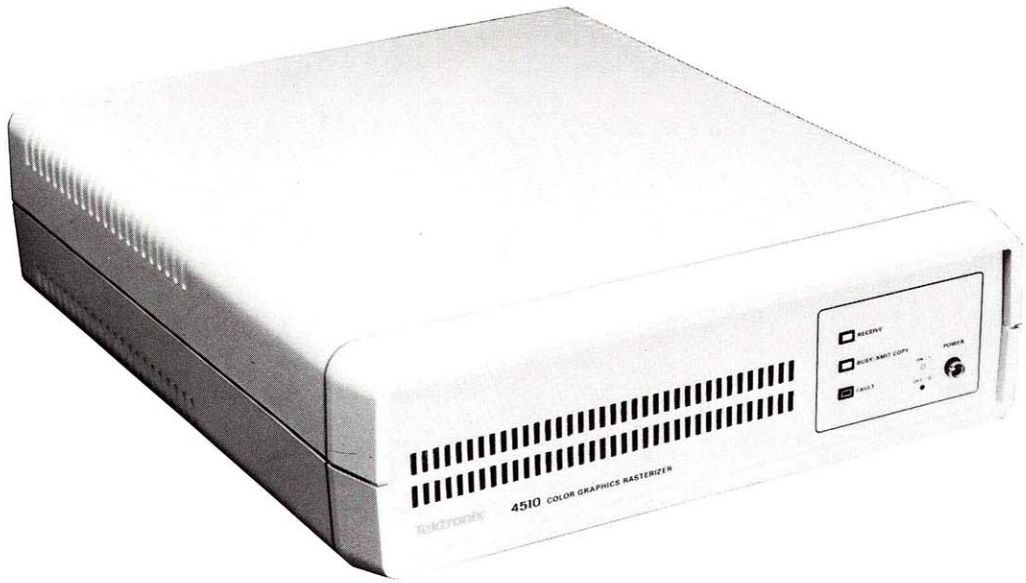
**See this color product in the reference section beginning on page 17.**



**OEM terms available on this product.**

NEW

COLOR GRAPHICS RASTERIZER




## 4510 Color Graphics Rasterizer

**Full Resolution Output to Tek 4692 and 4691 Color Graphics Copiers**

**RS-232, Four-Way Multiplexed Input**

**More than 274,000 Selectable Colors**

**Tek 4100 Series Command Set**

**Shared System Resource**

**The 4510 Color Graphics Rasterizer enhances the copy quality of the 4691 and 4692 Color Graphics Copiers by converting vector images into raster format.**
The result is hardcopy at the full resolution of the copier, rather than output limited to the resolution of the terminal. Blurred characters become crisp, jagged lines become smooth, even E-size engineering drawings can be legibly printed on B-size paper from the 4691. The 4510 also expands the color palette for the 4691 and 4692 to over 274,000 selectable colors.

### Shared System Resource
The 4510 accepts images from one or more hosts or workstations as high-level graphics commands across a 4-channel multiplexed RS-232 ASCII interface. It offloads the host from the rasterization and spooling tasks, resulting in faster throughput and lower CPU overhead. The 4510 cuts the cost per user by providing four different users access to the copier resource, and still maintains superior quality color hardcopy regardless of the type of terminals in use. Three separate memory options are available and accommodate approximately 200,000 vectors. The 4510 accommodates graphics images of various levels of complexity.

### Flexible Configuration
The 4510 supports a subset of the 4100/4110 Computer Display Terminal command set with minor modifications for use with a noninteractive hardcopy output resource. For "loop-through" mode operation from the host through the terminal's peripheral port interface, the 4510 can be connected directly to Tek 4106, 4107, 4109, 4113B, or 4115B Computer Display Terminals. The terminals can also drive the 4510 locally.

### CHARACTERISTICS
**Addressability** — 4096 x 4096 points.

**Resolution** — Up to 2048 x 4096 pixels, depending on copier resolution, media size and copy orientation.

**Graphic Command Syntax** — Tek 4100 Format.

**Line Types** — Solid and dashed lines, wide lines (vectors only); variable from 1 to 4 dots wide.

**Graphic Primitives** — Vectors, panels, markers, rectangles, alpha text, graphtext.

**Number of Colors** — 274, 625 selectable colors, 256 printable per image.

**Interfaces** — Input: 4-channel multiplexed modular RS-232 interface. Output: 8-bit parallel.

**Approximate Vector Capacity** — Option 30: 12,000. Option 31: 50,000. Option 32: 200,000.

**Data Rate** — Selectable 75 to 19,200 baud.

**Output Size** — Automatically senses copy size from copier; supports A, A4, B and A3 output sizes.

**Image Orientation** — Selectable for horizontal and vertical; image automatically scaled and rotated for copy size and orientation.

**International Character Sets** — UK, Swedish, Danish/Norwegian, German.

**Image Transformations** — Windowing.

#### AC POWER
**Line Voltage** — 87 V ac to 128 V ac, 174 V ac to 250 V ac, all of 48 Hz to 66 Hz.

**Input Power** — 120 W maximum.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 406 | 16.0 |
| Height | 135 | 5.3 |
| Depth | 478 | 18.8 |
| **Weight** | **kg** | **lb** |
| Net | 7.0 | 15.5 |

#### INCLUDED ACCESSORIES
Power cord (161-0066-00); RS-232 host port cable (012-0911-00); operator's manual.

### ORDERING INFORMATION
**4510*1 Color Graphics Rasterizer ..... $3,500**

**Option 30** — 128 kbytes total memory. (Capacity: Approximately 12,000 vectors) ..... **+$995**

**Option 31** — 512 kbytes total memory. (Capacity: Approximately 50,000 vectors) ..... **+$2,495**

**Option 32** — 2 Mbytes total memory. (Capacity: Approximately 200,000 vectors) ..... **+$6,495**

**1 Note: The 4510 must be ordered with a memory option.*

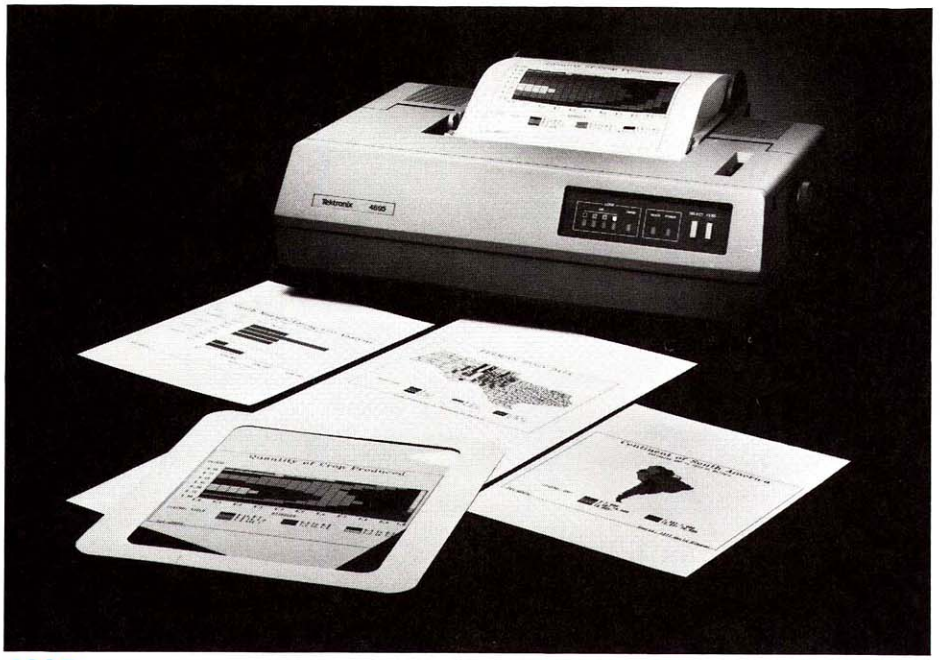
#### INTERNATIONAL POWER CORD AND PLUG OPTIONS
**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

***WARRANTY PLUS* SERVICE PLAN** REFER TO PAGE 14
**N1** — Service Plan + 9 Months Service ..... **+$85**
**N3** — OEM Service Plan +12 Months Service ..... **+$115**

#### OPTIONAL ACCESSORIES
**Copier Interconnect Cables** — Three meter, (10 ft). Order 012-0518-00 ..... **$130**
**Ten meter, (30 ft)** — Order 012-0527-00 ..... **$165**
**Programmer's Reference Manual** — Order 070-5043-00 ..... **$50**
**Pocket Reference Guide** — Order 070-5041-00 ..... **$10**
**Service Manual** — Order 070-5042-00 ..... **$150**

**See this color product in the reference section beginning on page 17.**

**OEM terms available on this product.**



## 4695 Color Graphics Copier

**Unprecedented Image Quality in its Price Range**

**Clear Transparency Capability**

**Quiet, 20 Character/Second Printing**

**Small, Compact Package**

**Choice of Roll or Sheet Paper**

**Compatible with IBM PC and PC XT**

### The 4695 Color Graphics Copier Provides Low Cost, High Performance Color Copying from the 4100 and 4110 Series Color Display Terminals and Other Raster Data Sources

The 4695's unique implementation of drop-on-demand ink-jet technology provides addressability of 4.8 dots per mm (120 dots per inch) in both horizontal and vertical directions. This allows up to 1280 points x 960 points per A size (8½ in x 11 in) image.

### A Multipurpose Output Device

In addition to providing high quality color graphics copies, the 4695 can function as a bi-directional, dot matrix printer with a print speed of 20 characters per second. A specially formulated clear transparency media can be used with the 4695 to develop striking, full color presentations. Paper is fed automatically from a roll or precut sheets are fed manually.

### Companion Copier for the 4100 and 4110 Series Color Terminal Family

The 4695 is plug-compatible with the entire 4100 Series (4105, 4106, 4107, 4109) and the 4110 Series (4113B and 4115B) color terminals. Copies are generated either by program command, or by pushing a button on the terminal keyboard. As a special feature, the 4695 can copy from the terminal graphics area while the dialog area continues to communicate with the host. The 4695 copies color shading patterns that are produced by the data source. These include the 125 callable shading patterns supported by 4110 Local Programmability, and 410X/4170 Local Programmability, and the 256 color patterns produced by the new enhanced firmware, 4110 Series Opt. 19.

### A Copier for Other Data Sources

The 4695's interface is modeled after the Centronics-style parallel interface, with modifications to support color. An optional software utility is available which allows the 4695 to make screen copies from the PC and PC XT IBM Personal Computers. In addition, detailed interface specifications and functional descriptions of driving routines are available from Tektronix. These documents can be used to reach compatability between the 4695 and data sources which have a Centronics-style parallel interface.

### CHARACTERISTICS

**Addressability** — Horizontal and Vertical: 4.8 dots/mm (120 dots/in).

**Copy Time** — 4105: 2 min to 3.5 min. 4106/4107/4109: 3 min to 5.25 min. 4113B: 6 min to 8.5 min. 4115B: 8.5 min to 17.5 min.

**Printing Speed** — 20 characters/s.

**Character Set** — Full ASCII including control characters.

**Printing Matrix** — 12 x 16 dot matrix.

**Page and Image Format** — A 216 mm x 279 mm (8½ in x 11 in) and A4 in 210 mm x 297 mm (8.3 in x 11.7 in). Landscape/Portrait format selectable under program control.

**Image Size** — 4105 Copy: 8 in x 6 in portrait format. 4106, 4107, 4109 Copy: 10.6 in x 8 in landscape format. 4113B Copy: 10.7 in x 8 in landscape format, 4 in x 5.3 in portrait; 4115B Copy: 10.7 in x 8.5 in landscape format.

**Colors** — Eight (magenta, yellow, cyan, red, green, blue, black, white).

**Media Types** — Paper sheet, paper roll, overhead transparency.

**Interface** — Eight bit parallel.

#### AC POWER

**Line Voltage** — 47 Hz to 63 Hz, 99 V ac to 132 V ac, 198 V ac to 264 V ac.

**Input Power** — 120 W or less.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 500 | 19.7 |
| Height | 151 | 5.9 |
| Depth | 336 | 13.2 |
| **Weight** | **kg** | **lb** |
| Net | 11.0 | 24.2 |

#### INCLUDED ACCESSORIES

One roll ink jet copy paper (016-0743-00); two each yellow (016-0734-00); magenta (016-0735-00); cyan (016-0736-00); black (016-0737-00); interconnecting cable (012-0555-00); power cable (161-0066-00); operator's manual.

### ORDERING INFORMATION

**4695** Color Graphics Copier ..... **$1,595**

**Option 01** — Screen Copier S/W for IBM Personal Computer ..... **+$100**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS*** **SERVICE PLAN** **REFER TO PAGE 14**

**N0** — Installation and Set-Up ..... **+$100**
**N1** — Service Plan + 9 Months Service ..... **+$430**
**N3** — OEM Service Plan + 12 Months Service ..... **+$570**

#### OPTIONAL ACCESSORIES

**Service Manual**
**Ink Jet Paper** — 6 rolls/pkg. Order 016-0743-00 ..... **$25**
**Ink Jet Paper, (500 sheets/pkg)**
**"A" Size** — 216 mm x 279 mm (8.5 in x 11.0 in). Order 016-0739-00 ..... **$25**
**"A4" Size** — 210 mm x 297 mm (8.3 in x 11.7 in). Order 016-0740-00 ..... **$22**
**Transparency Film** — 100 sheets/pkg. Order 016-0480-00 ..... **$85**
**Ink Jet Cartridges (2.5 cc ea, 16/pkg)**
**Yellow** — Order 016-0734-00 ..... **$25**
**Magenta** — Order 016-0735-00 ..... **$25**
**Cyan** — Order 016-0736-00 ..... **$25**
**Black** — Order 016-0737-00 ..... **$25**
**Maintenance Liquid** — Order 016-0732-00 ..... **$10**
**Protect Liquid (Shipping Fluid)** — Order 016-0733-00 .. **$4.00**
**Lubricant (5 cc)** — Order 016-0742-00 ..... **$1.65**



OEM terms available on this product.

## 4926 10 Megabyte Hard Disk

**5 1/4 Inch Winchester Technology**

**10 Megabyte Formatted Capacity**

**Easy Integration Through a Standard Interface**

**Complements 4110 Series Terminals with Local Programmability**

The 4926 is a 10 Mbyte hard disk drive that provides mass storage for 4110 Series terminals with local programmability. It gives users of 4110 Series terminals direct local access to large capacity mass storage, increasing applications flexibility and efficiency. The 4926 may also be configured with two optional flexible disks providing even more storage or removable media for backup.
The high capacity afforded by Winchester technology lowers the cost per Mbyte to the user and provides the level of local data storage and fast access time that interactive graphics require. Sealed drive heads also improve reliability and environment protection and reduce maintenance. The 4926 has 10 Mbytes formatted capacity, that can be increased in 10 Mbyte increments. Each 4926 cabinet can house two drives, using the same power supply, controller, and interface hardware. Terminal interfacing is easy with the Mass Storage Interface Bus (MSIB), Tektronix' implementation of the popular SCSI specification.

### CHARACTERISTICS

**Capacity** — Unformatted: 12.76 Mbytes. Formatted: 10.0 Mbytes.
**Access Times** — Average Access Time: 85 ms. Track-to-Track: 3 ms.
**Recording Surfaces** — 4 per drive.
**Recording Format** — 512 Bytes/Sector.
**Track Density** — 16 Sectors/Track.
**Average Latency** — 8.3 ms.
**Data Transfer Rate** — 10.2 kbytes/s max burst rate.
**Error Rates** — Recoverable (soft): 1 in $10^9$ bits. Nonrecoverable (hard): 1 in $10^{12}$ bits.
**Interfacing** — MSIB, Tektronix implementation of the SCSI described in ANSI document X3T9.2/82.2.

**AC POWER**

**Power Requirements** — 100 V ac to 125 V ac at 2 A; 180 V ac to 240 V ac at 1 A; 50 to 60 Hz.
**Power Consumption** — 140 W maximum.

**PHYSICAL CHARACTERISTICS**

| Dimensions | mm | in |
|---|---|---|
| Width | 368 | 14.5 |
| Height | 128 | 5.0 |
| Depth | 433 | 17.1 |
| **Weight** | **kg** | **lb** |
| Net | 6.4 | 14.0 |

**INCLUDED ACCESSORIES**

Power cable (161-0066-00); 6.5 ft 2 meter MSIB cable (Mass Storage Interface Bus) (012-0037-00); instruction manual.

### ORDERING INFORMATION

**4926** 10 Mbyte Hard Disk ..... **$4,200**
**Option 25** — Dual 5 1/4 in Flexible Disk; also Field Installable (Kit Number 4926F25) ..... **+$1,600**
**Option 26** — Additional 10 Mbyte Hard Disk Drive; also Field Installable (Kit Number 4926F26) ..... **+$2,200**
**Option 49** — Rental Tag ..... **NC**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 14**
**N1** — Service Plan + 9 Months Service ..... **+$210**

**OPTIONAL ACCESSORIES**

**Remote Power Cable (BNC)** — Order 012-0476-00 ..... **$23**
**Diskettes** — Pkg of 10 Order 119-1583-01 ..... **$55**

## 4970 Cluster Controller

**IBM SNA/SDLC Compatibility with 3270 Full Screen Emulation**

**Microprocessor Driven with Intel 8086**

**128 kbyte RAM Memory for Program Storage and Buffers. Communications Parameters Stored in Battery-Powered CMOS Memory.**

### The 4970 Cluster Controller and Companion Software Allow Tektronix Graphics Terminal Users to Access SNA, Multihost Environments

Communicating to the host like an IBM 3274 or 3276 Terminal Controller, the 4970 accepts asynchronous data (at rates up to 19.2 kbps) from as many as four Tek asynchronous ASCII terminals and converges it to a single synchronous EBCDIC data stream transmitted at data rates up to 9,600 bps. Allows Tek terminals to be used in 3270 full screen applications. Supports Tek graphics in 3270 communications environment.

### Increased Communications Efficiency

The 4970 reduces transmission line and port costs, since the 4970 system allows Tek graphics terminals to operate in a polled environment.

### Error Free Graphics

Network (SNA) error recovery is automatic, and since SDLC provides error checking, data integrity is assured at the link level.

### CHARACTERISTICS

**HOST INTERFACE**

**Mode** — Synchronous.
**Baud Rate** — 300 bps to 9600 bps.
**Code** — EBCDIC.
**Link Protocol** — SDLC.
**Network Compatibility** — SNA Physical Unit (PU) type 2; the 4970 looks like an IBM 3274 or 3276 to the host.
**Communication Media Supported** — Leased line/dial-up.

**TERMINAL SUPPORT**

**Mode** — Asynchronous.
**Baud Rate** — Selectable: 300 bps, 1200 bps, 2400 bps, 4800 bps, 9600 bps and 19.2 kbps.
**Code** — ASCII.
**Flagging** — DC1/DC3 or CTS/DTR.

**SELF-TEST CAPABILITY**

**Power-up** — Self-test routine.
**User-Initiated** — Extended self-test including DCE and DTE loopback for fault isolation.
**Stress Test** — Maximum/minimum voltage.

**DC 100 TAPE DRIVE**

For protocol program loading and creating back-up tapes.

**COMMUNICATIONS PARAMETERS**

**Method of Entry** — Password-protected monitor port in back panel.
**Parameter Volatility** — Battery-maintained CMOS maintains parameters through power-downs or outages.
**User-Selectable Parameters** — Controller address, terminal baud rate, echo, flagging mode, end-of-message (EOM) character, message size, controller S/N (for dial-up connection).

**FRONT PANEL INDICATORS**

**Port Status** — One LED for each terminal.
**Host Status** — One LED each for: Data Carrier Detect (DCD), Transmit Data (TD), Receive Data (RD).
**Ac Power** — On/off.

**AC POWER**

**Power Requirements** — 130 W maximum.
**Line Frequency** — 48 Hz to 62 Hz.
**Voltage Fuse** — Low Range: 90 V ac to 125 V ac, 2.5 A fast blow fuse. High Range: 175 V ac to 250 V ac, 1.5 A fast blow fuse.

**PHYSICAL CHARACTERISTICS**

| Dimensions | mm | in |
|---|---|---|
| Width | 406 | 16.0 |
| Height | 133 | 5.3 |
| Depth | 483 | 19.0 |
| **Weight ≈** | **kg** | **lb** |
| Net | 8.6 | 19.0 |

**INCLUDED ACCESSORIES**

Tape cartridge with current level SNA/SDLC software (4970P02), power cord (161-0066-00); 12 ft RS-232 modem I/F cable (012-0911-00); DTE loopback test adaptor (013-0211-00); DCE loopback test adaptor (013-0212-00); instruction sheet; user guide (070-4771-01); reference manual (070-4810-01).

### ORDERING INFORMATION

**4970** Cluster Controller ..... **$6,200**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 14**
**N1** — Service Plan + 9 Months Service ..... **+$215**

**OPTIONAL ACCESSORIES**

**Blank DC 100 Tape Cartridge** — Order 119-1350-00 .... **$25**
**Service Manual** — Order 070-4393-00 ..... **$50**

OEM terms available on these products.

## 4957 Graphic Tablet

**Graphic Input Capabilities for 4100 and 4110 Computer Display Terminals.**

**RS-232C Compatible**

### Simple Four-Button Cursor Control

To use the 4957, merely touch the four-button cursor-puck to the tablet's active area. The tablet calculates the coordinates and relays them to the host computer for storage or manipulation.

### Applications Fit

The 4957 can augment a terminal keyboard as a menu selection device, move a cursor around a display screen, or help transfer data from paper to a computerized database.

### Compatability

The 4957 is compatible with the Tek 4106, 4107, 4109 and 4110 Family of computer display terminals.

### CHARACTERISTICS

**Size** — 419 mm x 394 mm (16.5 in x 15.5 in).

**Active Writing Area** — 297 mm x 297 mm (11.7 in x 11.7 in).

**Resolution*1** — User selectable up to 1000 points/inch.

**Speed*1** — User selectable up to 90 coordinates/second.

**Accuracy** — ±.625 mm (0.025 in).

**Repeatability** — ±.250 mm (0.010 in).

**1 Maximum specs may not be accessible from various terminals.*

**INCLUDED ACCESSORIES**

Power supply and cord (119-1748-00); four-button cursor (119-1775-00); instruction manual.

### ORDERING INFORMATION

**4957** Graphics Tablet ..... **$895**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro, 220 V/16 A, 50 Hz
**Option A2** — UK, 240 V/13 A, 50 Hz
**Option A3** — Australian, 240 V/10 A, 50 Hz
**Option A5** — Switzerland, 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 14**

**N1** — Service Plan + 9 Months Service ..... **+$45**
**N3** — OEM Service Plan +12 Months Service ..... **+$55**

**OPTIONAL ACCESSORY**

**One Button Stylus** — Order 119-1776-00 ..... **$250**

## RGB Mixer

**Quick, High Resolution Gray Scale Copies off Color Terminals**

High resolution, gray scale copies can be made from a color terminal without composite video, with the aid of Tektronix' RGB Mixer and the 4632 Video Hard Copy Unit or 4634 Imaging Hard Copy Unit.

If you need a quick, quiet, quality, hard copy from your IBM 3279 terminal*1 or similar terminals, the low cost RGB mixer will enable to hook up a Tektronix 4632 or 4634 Hard Copy Unit to your system.

Besides the IBM 3279, other terminals that have been successfully tested in this configuration include:

Ramtek 6211
Mitsubishi 3919
Lexidata 3400

The mixer requires five BNC cables to operate: four are inputs from the terminal, and the fifth is the composite video output to the copier. Four channel multiplexing is available (with one mixer per terminal), as a remote copy button capability.

**1 IBM 3279 users should have either Model 3B with video out option, or Model 3X with feature 8750. Also, Model S3G's can be converted to Model 3X.*

### ORDERING INFORMATION

**RGB MIXER** (016-0596-00) ..... **$425**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro, 220 V/16 A, 50 Hz
Order 016-0596-01.
**Option A2** — UK, 240 V/13 A, 50 Hz
Order 016-0596-02.
**Option A3** — Australian, 240 V/10 A, 50 Hz
Order 016-0596-03.
**Option A4** — North American, 240 V/15 A, 60 Hz
Order 016-0596-04.
**Option A5** — Switzerland, 220 V/10 A, 50 Hz
Order 016-0596-05.

**OPTIONAL ACCESSORIES**

**Remote Copy Button** — (For 4632). Order 016-0722-00 ..... **$110**
**BNC Cable** — 10 ft. Order 175-2753-00 ..... **$23**



**OEM terms available on these products.**

4611

## 4611 Hard Copy Unit

**Low Copy Cost**

**High Contrast, Permanent Images**

**Electrostatic Process**

**Storage Tube Compatible**

The 4611 provides low cost, high quality copies of complex graphics and alphanumerics from storage tube displays at the press of a button. The 4611 is based on electrostatic (charge transfer) technology, and uses electrographic paper for high contrast, permanent copies at an economical per-copy cost.

The 4611's high addressability and dot overlap result in uniquely dark, smooth lines for optimum copy quality. The dry toning system employed by the 4611 is cleaner, more convenient and more consistent than liquid toning systems. Images are permanently fused and made from inert, safe ingredients. Typical user applications include quick preview copies before final plotting, copies of intermediate steps during interactive work sessions, and final output copies for reports, presentations, and file records. Copies can be produced in both portrait and landscape format.

Compact and lightweight, the 4611 can be easily moved from desk to desk. It also can be multiplexed to copy up to four teminals and/or display monitors. Warm up lights and paper-out indicators are provided.

The 4611 is compatible with the Tektronix 4010 Series of Computer Display Terminals, the (4114, 4114A, 4116A, 4025, and the 4025A) Terminals, the 4050 Series of Graphic Computing Systems, and the 4081 Interactive Graphics Terminal. The 4611 is also compatible with Tektronix 11 and 19 inch computer display modules.

### CHARACTERISTICS

**Warm-up Time** — Two minutes.
**Copy Time** — 24 s (vertical format).
**Paper Type** — Electrographic (dielectric).
**Image Size** — Vertical Format: 190 mm x 147 mm (7.5 in x 5.8 in). Option 31: 190 mm x 226 mm (7.5 in x 8.9 in).
**Addressability** — Vertical: 171 dots/in. Horizontal: 256 dots/in.
**Toner** — Dry magnetic.

#### AC POWER

**Voltage Range** — 90 V ac to 128 V ac and 180 V ac to 250 V ac. (High range requires Options A1, A2, A3 or A4).
**Line Frequency** — 48 Hz to 62 Hz.
**Power** — Warm-up: 300 W nominal, 370 W maximum. Operating: 215 W nominal, 290 W maximum. Idle: 120 W nominal, 185 W maximum.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 425 | 16.7 |
| Height | 181 | 7.1 |
| Depth | 625 | 20.6 |
| **Weight** | **kg** | **lb** |
| Net | 20.0 | 45.0 |

#### INCLUDED ACCESSORIES

Power cord (161-0066-00); 10 ft 15-pin hard copy cable (012-0547-00); two rolls/case electrographic paper (006-2838-00); 4.9 oz dry copy toner (006-2990-00); operator's manual.

### ORDERING INFORMATION

**4611** Hard Copy Unit ..... **$5,050**
**Option 02** — Four-Channel Multiplexer ..... **+$660**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS*** **SERVICE PLAN** **REFER TO PAGE 14**

**N1** — Service Plan + 9 Months Service ..... **+$515**
**N3** — OEM Service Plan +12 Months Service ..... **$685**

#### OPTIONAL ACCESSORIES

**Interconnect Cable** — 14-pin (20 ft). Order 012-0548-00 ..... **$220**
**Interconnect Cable** — 15-pin (50 ft). Order 012-0549-00 ..... **$305**
**Extender Cable** — For servicing only. Order 175-3421-00 ..... **$36**

#### PAPER & TONER

**Electrographic Paper** — 2 rolls/case. Order 006-2838-00 ..... **$35**
**Dry Copy Toner** — 4.9 oz. Order 006-2990-00 ..... **$23**

## 4631 Hard Copy Unit

**High Image Quality, Copies in Seconds**

**Fiber Optic Process**

**Storage Tube Compatible**

The 4631 Hard Copy Unit provides superior quality copies of any graphic and alphanumeric information displayed on a storage tube display. The 4631's fiber optic process uses Dry Silver paper for the fine detail and photographic quality image needed when copying complex graphics and alphanumerics. It requires no toners or chemical additives of any kind. Copies can be made in either vertical or horizontal format. A special "slow scanning" mode allows images on the horizontal format to be made at even higher resolution and image quality.

The 4631 can be multiplexed to copy up to four storage tube terminals and/or display monitors. It is compatible with the Tektronix 4010 Series of Computer Display Terminals, the 4114B and 4116B Terminal, the 4025 and 4025A Terminal,the 4050 Series of Graphic Computing Systems, and the 4081 Interactive Graphics Terminal. The 4631 is also compatible with Tektronix 11 and 19 inch computer display modules.

4631

### CHARACTERISTICS

**Warmup Time** — Ten minutes.
**Normal Scan** — 18 s first copy; 9 s subsequent.
**Slow Scan** — 36 s first copy; 16 s subsequent.
**Paper Size** — 216 mm x 277 mm (8.5 in x 11 in).
**Paper Type** — Std Dry Silver (500 ft roll).
**Addressability, Normal Scan** — Vertical: 79 dots/cm (200/in). Horizontal: 67 dots/cm (170/in).
**Slow Scan** — Vertical: 118 dots/cm (300/in). Horizontal: 134 dots/cm (340/in).
**Image Size** — Vertical Format: 180 mm x 137 mm (7.1 in x 5.4 in). Horizontal Format: 225 mm x 170 mm (8.85 in x 6.7 in). Option 31: 163 mm x 190 mm (6.4 in x 7.5 in).

#### AC POWER

**Voltage Range, Standard** — 104 V ac to 126 V ac.
**Strappable Low Range** — 90 V ac to 110 V ac.
**Strappable High Range** — 108 V ac to 132 V ac.
**Power, Warmup** — 620 W nominal; 750 W on high range.
**Power, Copy Process** — 200 W nominal; 240 W on high range.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 406 | 16.0 |
| Height | 295 | 11.6 |
| Depth | 648 | 25.5 |
| **Weight** | **kg** | **lb** |
| Net | 29.5 | 65.0 |

#### INCLUDED ACCESSORIES

10 ft 15-pin interconnect cable (012-0547-00); 500 ft roll standard dry silver paper (006-1603-00); user's manual.

### ORDERING INFORMATION

**4631** Hard Copy Unit ..... **$6,500**
**Option 01** — Copy Counter ..... **+$150**
**Option 02** — Four Channel Multiplexer ..... **+$730**
**Option 31** — Compatible with Tektronix 4025 and 4025A Terminals ..... **NC**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A 50 Hz
**Option A2** — UK 240 V/13 A 50 Hz
**Option A3** — Australian 240 V/10 A 50 Hz
**Option A4** — North American 240 V/15 A 60 Hz
**Option A5** — Switzerland, 220 V/10 A, 50 Hz

***WARRANTY-PLUS*** **SERVICE PLAN** **REFER TO PAGE 14**

**N1** — Service Plan + 9 Months Service ..... **+$600**
**N3** — OEM Service Plan +12 Months Service ..... **+$800**

#### OPTIONAL ACCESSORIES

**Interconnect Cable 15-pin (20 ft)** — Order 012-0548-00 ..... **$220**
**Interconnect Cable 15-pin (50 ft)** — Order 012-0549-00 ..... **$305**
**Service Manual**

4612

## 4612 Video Hard Copy Unit

**Low Copy Cost**

**High Contrast, Black and White Images**

**Electrostatic Process**

**Video Source Compatible**

Hard copy units such as the 4612 provide quick and convenient copies of complex information that has been displayed on a screen. These devices are essential to the use of graphic terminals, desktop computing systems, and video image processing systems. To fulfill a variety of user needs, graphic and alphanumeric information is permanently recorded on paper at the press of a button. These needs include quick preview copies before final plotting, copies of intermediate steps during interactive work sessions, and final output copies for reports, presentations, and file records.

The 4612 provides permanent black-and-white copies of graphic and alphanumeric information from raster scan terminals and other video signal sources. Based on electrostatic technology, the 4612 uses electrographic paper for high contrast copies at an economical copy cost. The 4612 is compatible with the Tektronix 4025A terminal, the 4112A Option 11 terminal, and with a wide variety of raster scan terminals and video signal sources including DEC VT100 Series terminals, DEC MINC Systems and those sources that produce RS-170, RS-330 or RS-375A type signals.

The 4612 is compact and lightweight, and can easily be moved from desk to desk. Its unique dry toning process is convenient, non-messy and superior to liquid toner systems. Images are permanently fused and made from inert, safe ingredients. Warm-up lights and paper-out indicators are provided. All copies are vertically oriented. The 4612 can be multiplexed to copy up to four terminals and/or display monitors with Option 02.

The standard 4612 unit is prepared for use with 525 line, 60 Hz sources. Adjustment for 625 line, 50 Hz is provided as an option.

### CHARACTERISTICS

**Warm-up Time** — Two minutes.
**Copy Time** — 24 s.
**Paper Type** — Electrographic (dielectric).
**Image Size** — 7.5 x 5.8 std (525 line, 60 Hz signals).
**Addressability** — Horizontal: 256 dots/in. Vertical: 171 dots/in.
**Toner** — Dry magnetic.

**AC POWER**

**Voltage Range** — 90 V ac to 128 V ac and 180 V ac to 250 V ac. (High range requires Options A1, A2, A3 or A4.)
**Warm-up** — 300 W nominal, 370 W maximum.
**Copy Process** — 215 W nominal, 290 W maximum.
**Idle** — 120 W nominal, 185 W maximum.

**PHYSICAL CHARACTERISTICS**

| Dimensions | mm | in |
|---|---|---|
| Width | 425 | 16.7 |
| Height | 181 | 7.1 |
| Depth | 525 | 20.6 |
| **Weight ≈** | **kg** | **lb** |
| Net | 20.0 | 45.0 |

**INCLUDED ACCESSORIES**

Power cord (161-0066-00); two rolls/case electrographic paper (006-2838-00); 4.9 oz dry copy toner (006-2990-00); 10 ft BNC interconnect cable (175-2753-00); operator's manual.

### ORDERING INFORMATION

**4612** Video Hard Copy Unit ..... **$4,690**
**Option 02** — Four-Channel Multiplexer ..... **+$660**
**Option 03** — Setup for 625/50 Hz Scanning Std ..... **NC**
**Option 08** — Setup for DEC VT100 Series Terminals ..... **NC**
**Option 15** — Video Input 15-pin Connector ..... **NC**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 14**

**N1** — Service Plan + 9 Months Service ..... **+$515**
**N3** — OEM Service Plan +12 Months Service ..... **$685**

**OPTIONAL ACCESSORIES**

**Interconnect Cable, (BNC 10 ft)** — Order 175-2753-00 **$23**
**Interconnect Cable, BNC (25 ft)** — Order 012-0157-00 .. **$100**
**"T" Connector, BNC** — Order 103-0030-00 ..... **$6.50**
**Interconnect Cable, 15-pin (10 ft)** — Order 012-0504-00 ..... **$150**
**Interconnect Cable, 15-pin (20 ft)** — Order 012-0504-01 ..... **$155**
**Interconnect Cable, 15-pin (50 ft)** — Order 012-0504-02 ..... **$200**
**Extender Cable** — For servicing only. Order 175-3421-00 **$36**
**Remote Copy Button** — Order 016-0722-00 ..... **$110**
**Remote Copy Button and 25 ft Cable** — Order 016-0722-01 ..... **$180**
**Remote Copy Button and 50 ft Cable** — Order 016-0722-02 ..... **$220**
**25 ft Cable for Remote Copy Button** — Order 012-0985-00 ..... **$65**
**50 ft Cable for Remote Copy Button** — Order 012-0986-00 ..... **$100**

**PAPER & TONER**

**Electrographic Paper** — Two rolls/case. Order 006-2838-00 ..... **$45**
**Dry Copy Toner** — 4.9 oz. Order 006-2990-00 ..... **$23**
**Service Manual**

## 4632 Video Hard Copy Unit

**Copies Many Color Displays**

**Gray Scale Capability**

**Copies in Seconds**

**Video Source Compatible**

The 4632 provides permanent copies of graphic and alphanumeric information from raster scan terminals and other video signal sources. All copies are horizontally oriented. Eight distinct shades of gray can be copied with a special gray scale enhancement option. The standard 4632 can clearly show six different shades of gray, for polygon fill-in, bar charts, and many other applications. With the RGB Mixer, the 4632 can be used to copy many color displays for quick working copy applications.

With Option 02, the 4632 can be multiplexed to copy up to four raster scan terminals, and can accept remote copy signals. The 4632 is compatible with the Tektronix 4020 Series, 4112, 4112A, 4113, 4113A terminals and with a wide variety of raster scan terminals and video signal sources, including those that produce RS-170, RS-330, RS-375A, RS-343A and RS-412A type signals. The 4632 is also compatible with VT100 Series terminals, the HP 2640 Series, the AT&T Gemini 100 Systems, and an optional RGB mixer provides 4632 compatibility with many color displays such as the IBM 3279.

The standard 4632 is prepared for use with 525 line, 60 Hz sources. Many other adjustments are provided as options, including adjustments for 625 line, 50 Hz and for high resolution 1029 line, 60 Hz.

4632

### CHARACTERISTICS

**Warmup Time** — Ten minutes.
**Copy Time** — 18 s first copy; 9 s subsequent copies.
**Paper** — Size: 216 mm x 277 mm (8.5 in x 11 in). Type: Std Dry Silver (500 ft roll).
**Addressability** — Incoming signal dependent.
**Image Size** — 203 mm x 152 mm (8 in x 6 in).
**Gray Levels** — Six min (8 w/Option 06).

**AC POWER**

**Voltage Range, Standard** — 104 V ac to 126 V ac.
**Strappable** — Low Range: 90 V ac to 110 V ac. High Range: 108 ac to 132 V ac.
**Warmup** — 620 W nominal, 750 W maximum.
**Copy Process** — 200 W nominal; 240 W maximum.
**Idle** — 120 W nominal, 185 W maximum.

**PHYSICAL CHARACTERISTICS**

| Dimensions | mm | in |
|---|---|---|
| Width | 406 | 16.0 |
| Height | 295 | 11.6 |
| Depth | 648 | 25.5 |
| **Weight ≈** | **kg** | **lb** |
| Net | 29.5 | 65.0 |

**INCLUDED ACCESSORIES**

500 ft roll standard dry silver paper (006-1603-00); 75 Ω BNC terminator (011-0102-00); user's manual.

The 4632 is not shipped with an interconnect cable; order the desired cable from the following optional accessories list.

### ORDERING INFORMATION

**4632** Video Hard Copy Unit ..... **$6,500**
**Option 01** — Copy Counter ..... **+$150**
**Option 02** — Four Channel Multiplexer ..... **+$730**
**Option 03** — Setup for 625 Line/50 Hz ..... **NC**
**Option 04** — Setup for 1029 Line/60 Hz ..... **NC**
**Option 05** — Setup for Tektronix 4023 Terminal ..... **NC**
**Option 06** — Enhanced Gray Scale ..... **+$970**
**Option 07** — Compatible with HP 2640 Series Terminals ..... **+$150**
**Option 08** — Compatible with DEC MINC Systems .. **+$150**
**Option 09** — Setup for AT&T GEMINI 100 Systems . **+$150**
**Option 10** — Set up for 4109 ..... **NC**
**016-0596-00** — RGB Mixer ..... **$425**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 14**

**N1** — Service Plan + 9 Months Service ..... **+$600**
**N3** — OEM Service Plan +12 Months Service ..... **+$600**

**OPTIONAL ACCESSORIES**

**Interconnect Cable, 15-pin (10 ft)** — Order 012-0504-00 ..... **$150**
**Interconnect Cable, 15-pin, (20 ft)** — Order 012-0504-01 ..... **$155**
**Interconnect Cable, 15-pin, (50 ft)** — Order 012-0504-02 ..... **$200**
**Interconnect Cable, BNC, 75 Ω (25 ft)** — Order 012-0157-00 ..... **$100**
**Remote Copy Button** — Order 016-0722-00 ..... **$110**
**Remote Copy Button and 25 ft Cable** — Order 016-0722-01 ..... **$180**
**Remote Copy Button and 50 ft Cable** — Order 016-0722-02 ..... **$ 220**
**25 ft Cable for Remote Copy Button** — Order 012-0985-00 ..... **$65**
**50 ft Cable for Remote Copy Button** — Order 012-0986-00 ..... **$100**
**RGB Video Mixer** — Order 016-0596-00 ..... **$425**

**PAPER**

**Standard Dry Silver Paper (500 ft roll)** — Order 006-1603-00 ..... **$90**
**Standard Dry Silver Paper, (4 rolls/carton)** — Order 006-1603-01 ..... **$320**
**Service Manual**

OEM terms available on these products.

## 4634 Imaging Hard Copy Unit

### Excellent Gray Scale and Resolution

### Quick Working Copy for Color Systems

The 4634 Imaging Hard Copy Unit records images of photographic quality from most TV video sources, both analog and digital. The 4634 can be quickly adjusted to accommodate a wide variety of line rates, for both 50 Hz and 60 Hz systems.

It uses a fiber-optic CRT and thermal processor to produce a finished image with excellent resolution and gray scale in less than half a minute. Cost per copy for large, file-sized images is low. An optional RGB mixer provides 4634 compatibility with many color displays such as the IBM 3279.

Video information is input through rear panel connectors. In most cases a simple BNC connector is all that's required.

The 4634 is available as either a rackmount or benchtop model.

### CHARACTERISTICS

**Recording Medium** — Dry Silver Paper; Tektronix' High Performance (7772) Paper or switch selectable to Tektronix' Standard (7770) Paper.
**Paper Packaging** — Rolls of paper encased in light-sealed cylindrical cassettes.
**Paper Dimensions** — 216 mm x 152 m (8.5 in x 500 ft).
**Shelf Life of Tektronix Paper** — 12 months at +20°C with 50% relative humidity.
**Recording Technique** — Raster scan video with fiber optic CRT.
**Developing Technique** — Heat via internal processor.
**Warmup Time** — 20 min.
**Copy Time** — 26 s.
**Exposure Time (11 in Copy)** — 8.5 s.
**Copy Repetition Rate** — ≈12 s.
**Copy Length Range** — 178 mm to 279 mm (7.0 in to 11.0 in) in 19 mm (3/4 in) increments.
**Horizontal Image Size Range** — 127 mm to 203 mm (5 in to 8 in) for 60 Hz field rate; 152 mm to 203 mm (6 in to 8 in) for 50 Hz field rate.
**Vertical Image Size Range** — Adjusts for correct aspect ratio.
**Gray Shades** — 12 w/Tektronix High Performance (7772) Paper. Six w/Tektronix Standard (7770) Paper.
**Resolution** — At least 4.92 lines/mm (125 lines/in) w/Tektronix High Performance (7772) Paper. At least 3.94 lines/mm (100 lines/in) w/Tektronix Standard (7770) Paper.

#### AC POWER

**Line Voltage Range (±10%)** — Jumper selectable for 100 V ac, 115 V ac, 120 V ac, 200 V ac, 220 V ac, 230 V ac and 240 V ac.
**Line Frequency** — 48 Hz to 62 Hz.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 425 | 16.7 |
| Height | 266 | 10.5 |
| Depth | 686 | 27.0 |
| **Weight ≈** | **kg** | **lb** |
| Net | 30.5 | 67.0 |

#### INCLUDED ACCESSORIES

500 ft roll high performance dry silver paper (006-2432-00); 75 Ω terminator (001-0131-00); instruction manual (for 4634 OEM); instruction manual (for 4634 Option 45).
The 4634 is not shipped with an interconnect cable; order the desired cable from the following optional accessories list.

### ORDERING INFORMATION

**4634** Imaging Hard Copy Unit ..... **$7,900**
**Option 09** — Set up for 4109 ..... **NC**
**Option 30** — Delete Rackmount Hardware ..... **−$85**
**Option 45** — End-User Set-up ..... **NC**
**016-0596-00** — RGB Mixer ..... **$425**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz

***WARRANTY-PLUS*** **SERVICE PLANS REFER TO PAGE 14**

**N1** — Service Plan + 9 Months Service ..... **+$600**
**N3** — OEM Service Plan +12 Months Service ..... **+800**

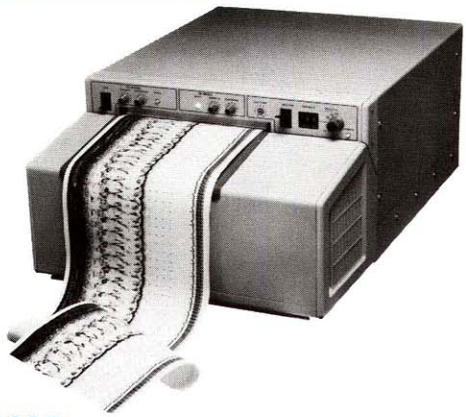
#### OPTIONAL ACCESSORIES

**Cable** — 75 Ω (42 in) BNC. Order 012-0074-00 ..... **$17.50**
**Board Extender** — Order 067-0687-01 ..... **$135**
**Card Extender** — Order 067-0708-00 ..... **$95**
**Interconnect Cable** — 15-pin, (10 ft). Order 012-0504-00 ..... **$200**
**Interconnect Cable** — 15-pin, (20 ft). Order 012-0504-01 ..... **$155**
**Interconnect Cable** — 15-pin, (50 ft). Order 012-0504-02 ..... **$200**
**RGB Video Mixer** — Order 016-0596-00 ..... **$425**

#### PAPER

**High Performance Dry Silver Paper** — 500 ft roll. Order 006-2432-00 ..... **$215**
**High Performance Dry Silver Paper** — Four rolls/carton). Order 006-2432-01 ..... **$750**

**OEM terms available on the 4634.**



## 4635 Imaging Recorder

### Combined Line Scan/TV Imager

### Superior Image Quality

### Excellent Gray Scale and Resolution

### Choice of Two Recording Media

### Available Only to Qualified OEMs

The 4635 Imaging Recorder produces high-quality gray-scale images from both line scan and composite TV video sources. It is optimized for the requirements of diagnostic ultrasound, but can also be used for other applications requiring dual mode recording capability.

The 4635 records on two types of photographic Dry Silver Paper: a High-Performance Paper for applications demanding extended gray scale and a lower cost standard paper for limited gray-scale needs. The 4635 can withstand heavy usage demands, processing a minimum of 50 rolls of paper (25,000 feet) between planned maintenance.

Images produced by the 4635 are exposed using a CRT with a fiber-optic faceplate. Tiny fiber-optic filaments in the faceplate transmit the light output of the CRT to the paper.

Following exposure the paper is advanced through a thermal processor, where the latent image is developed. The fully processed image then exits the recorder through a front-panel opening.

The 4635's combination of superior imaging capability, rugged design, and low cost operation make it the standard for quality and value among imaging recorders.

### CHARACTERISTICS

**Recording Technique** — Exposing photographic Dry Silver Paper with light output from a fiber-optic CRT (Cathode Ray Tube).
**Developing Technique** — Heating the Dry Silver Paper in an internal processor.

#### IMAGE SIZE

**Line Scan** — Width is adjustable from 100 mm to 200 mm.
**TV, Horizontal** — 60 Hz: 125 mm to 210 mm. 50 Hz: 150 mm to 210 mm.
**TV, Vertical** — Adjustable to provide correct aspect ratio.

#### IMAGE FORMATS

**Line Scan** — Successive lines written across width of paper, perpendicular to path of exiting paper, continuous recording.
**Raster Scan TV** — Raster lines written in direction of paper path. OEM can select either cut TV page or TV frame insertion into continuous line scan recording.

#### IMAGE

**Density Range** — High Performance Paper: Min 0.2, maximum 1.4. Standard Paper: 1.2.
**Shades of Gray** — TV Page: 12 levels for High Performance Paper, 8 levels for Standard Paper. Line Scan: 8 levels for High Performance Paper, 6 levels for Standard Paper.
**Resolution** — Four cycles per mm in line. Two cycles per mm in TV page.

#### RECORDING MEDIA

**Material** — Tektronix High Performance Dry Silver Paper or Tektronix Standard Dry Silver Paper.
**Paper Roll Dimensions** — 152 m (500 ft) long, 216 mm (8.5 in) wide.

#### PAPER SPEEDS

**Lines Scan** — 10 mm/s to 100 mm/s.
**TV Page** — 35 mm/s.

#### POWER SPECIFICATIONS

**Voltage Ranges (±10%)** — 100 V ac, 115 V ac, 120 V ac, 200 V ac, 220 V ac, and 230 V ac or 240 V ac
**Line Frequency** — 48 Hz to 62 Hz.
**Power Consumption** — 800 W maximum peak power demand.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 425 | 16.8 |
| Height | 266 | 10.5 |
| Depth | 667 | 26.3 |
| **Weight ≈** | **kg** | **lb** |
| Net | 34.0 | 75.0 |

#### INCLUDED ACCESSORIES

500 ft roll high performance dry silver paper (006-2432-00).

### ORDERING INFORMATION

**4635** Imaging Recorder

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

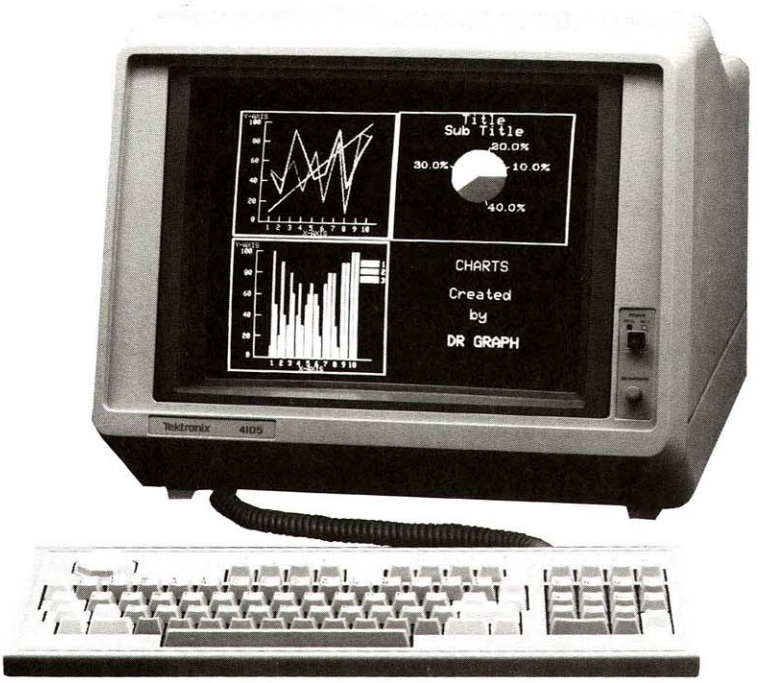
***WARRANTY-PLUS*** **SERVICE PLANS REFER TO PAGE 14**

**N1** — Service Plan + 9 Months Service.
**N3** — OEM Service Plan +12 Months Service.

**Available only to qualified OEM's.**

NEW

PERSONAL PRODUCTIVITY TOOLS




**Personal Productivity Tools**

**Compatible with all Tek 4110B Series Raster Terminals Using Local Programmability and 410X Series Terminals (with the 4170 Local Graphics Processing Unit)**

**Data Exchange with Other Business Software and User-Written CP/M-86*1 Applications**

**Hardcopy Support from Tektronix Color Copiers and Plotters**

**Tektronix offers a set of personal productivity tools for use in 4100 and 4110 Local Programmability Units.**
This collection of business-oriented application software is comprised of several popular personal computer packages, including WordStar*2 Word Processing, SuperCalc2*3 Spreadsheet, DR Graph*4 Interactive Graphing, and InfoStar*5 Data Base Management.

### WordStar
WordStar has become the most popular word processing package for microcomputers in the world. A sophisticated tool for the preparation of all kinds of written communication or computer programs, WordStar is a screen editor, showing you exactly how your document will look when printed. WordStar is designed for the nontechnical user and features on-line help menus and full prompting instructions at four different experience levels.

Powerful editing commands allow you to delete characters, lines or blocks of text; move, copy or delete blocks; find and replace items; realign blocks; read to and write from other files; and many other kinds of text manipulation. Flexible print commands give the user control over page length; top, bottom and side margins; headings and footing markers and page number locations. File management, including saving, copying, naming and transferring documents, is simple enough for the novice to understand.

### SuperCalc2
SuperCalc2 allows Local Programmability users to create a comprehensive electronic spreadsheet in ten minutes or less. Balance sheets, profit and sales projections, job cost estimates, general ledgers, cash flow analyses and inventory controls are only a few of the accounting reports possible. SuperCalc2 prompts the user each step of the way in designing spreadsheets and manipulating data into desired formats. All row and columns can be sorted alphabetically or numerically and entire row/column value ranges computed. A "black box" capability even allows you to write canned spreadsheet applications that others can execute by following prompts.

### DR Graph
DR Graph Interactive Graphing package enables the nontechnical user to create and edit a wide variety of business graphs in minutes. Line, bar, pie, step, stick and scatter graphs are among the many possibilities. Following prompts, the user creates the graph on his terminal, and DR Graph automatically plots the data points. Among user-defined parameters are line width, style and color; text font, size and text placement; and color selections. Graphs can easily be output on Tek's full line of hardcopy devices, including ink jet copiers and plotters, which produce high-quality output on paper and transparency media.

### InfoStar
InfoStar is a menu-driven data base management system that allows the first-time user to effectively manipulate data without learning a data base language. The system provides four different help levels, giving extensive aid to the beginner without encumbering the experienced user.

InfoStar allows duplication of documents on-screen for fast data entry. As data is entered, the system automatically generates indices from user-specified fields. Up to 25 key fields can be designated, with each file capable of holding over 65,000 records. Once data is in the system, a high-speed sort facility quickly arranges data into user-specified order. Up to 255 files can be open at one time, providing tremendous flexibility in combining data.

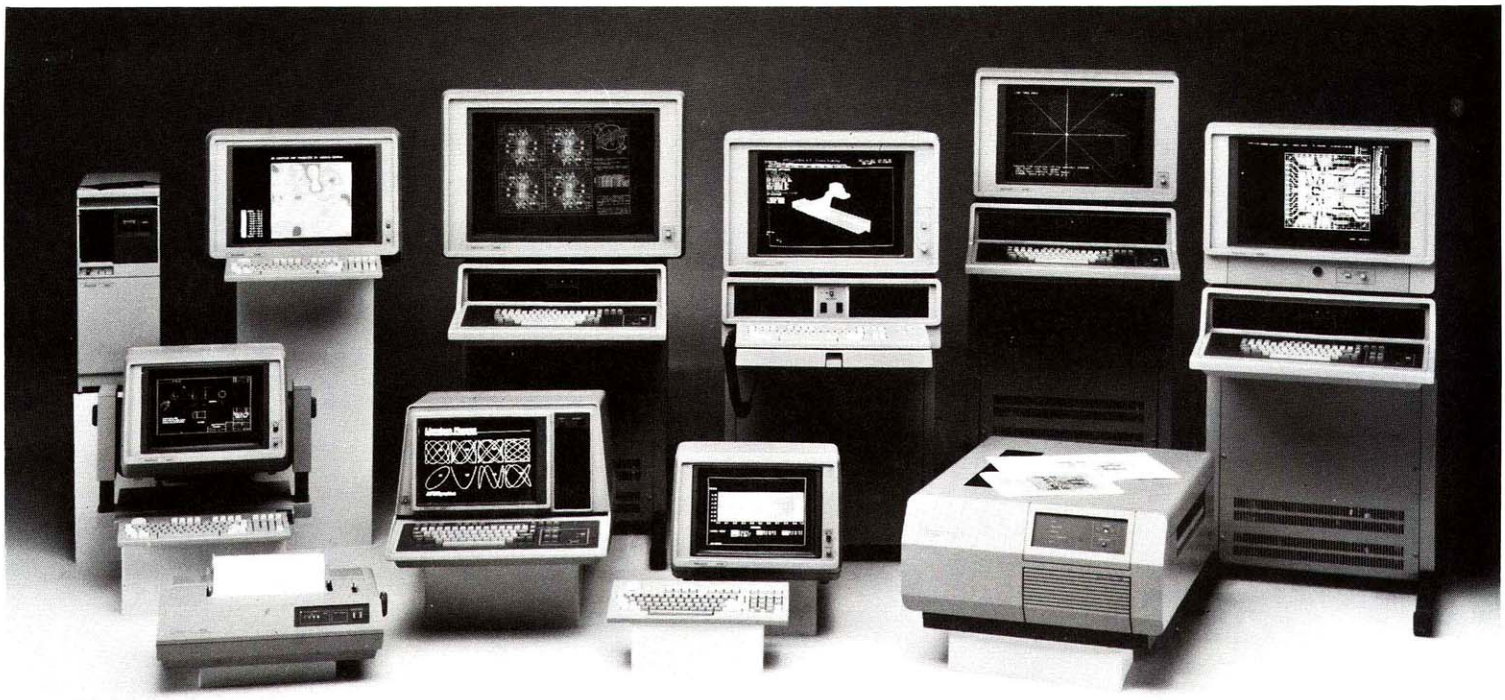
A quick-report feature allows a variety of reports to be created in less than a minute, while a custom-report feature provides a means of producing more elaborate report formats.

### Compatible Business Software
Tektronix personal productivity software supports a common data exchange, enabling data to be transferred from one package to another. For instance, financial data from SuperCalc2 could be copied to DR Graph and plotted as a bar chart. These packages can also exchange data with user-written CP/M-86 programs. All data can be written as ASCII files, enabling a user-written FORTRAN or Assembly language program to access and manipulate the files.

**ORDERING INFORMATION**

**4100P22** — SuperCalc2 Spreadsheet ... **$325**
**4100P24** — InfoStar Data Base Management ..... **$550**
**4100P25** — DR Graph Interactive Graphing ..... **$210**
**4100P27** — WordStar Word Processing ..... **$550**
**Option 01** — 8 In Diskette ..... **NC**
**Option 02** — 5 ¼ In Diskette ..... **NC**
**Option 10** — 4170 with CP/M (Requires Option 02) ..... **NC**
**Option 11** — 411X with CP/M-86 (Requires Option 01) .. **NC**

*1 *CP/M-86 is a registered trademark of Digital Research.*
*2 *WordStar is a registered trademark of MicroPro International Corporation.*
*3 *SuperCalc2 is a registered trademark of Sorcim Corporation.*
*4 *DR Graph is a trademark of Digital Research.*
*5 *InfoStar is a trademark of MicroPro International Corporation.*





# Local Programmability

## For 4110B, 410X Series Terminals

**Powerful State-Of-The-Art Graphics Under User-Written Software Control**

**Local Access to Graphics Manipulation Capabilities**

**CP/M-86**

**ANSI FORTRAN 77**

**Core Graphics Package (PLOT 10 IGL)**

### Local Programmability Puts Graphics Computer Power in the Hands of the User

The 4110B/410X Series Local Programmability gives terminals independence from host computers by equipping them with local intelligence and processing power. Local Programmability supplies the elements needed to locally develop and run programs; to access the graphics and alphanumeric features resident in the 4110B Series and 410X firmware; and to control peripherals connected to the terminal.

The package for 4110B Series terminals consists of a disk-based CP/M-86 operating system, FORTRAN-86 compiler, ASM-86 or ASM86 macro assembler; utility programs; and a library of Direct Terminal Interface (DTI) subroutines that enable the FORTRAN programmer to exercise all 4100 Series terminal features. All package components are also available on the 4170 with 410X terminals. Optionally, a local version of Tektronix' PLOT 10 IGL is available.

### Increased Productivity Through Distributed Processing

Local Programmability gives the user the flexibility to run programs locally or through a host. By promoting more efficient use of the host system, Local Programmability cuts costly CPU time, frees the host to do the kinds of processing it does best, and allows the host to support more terminals. Many CAD/CAM, data analysis and graphing applications can be written and run entirely without host support.

### Software Compatibility Across 4100 Line

User-developed software using the Direct Terminal Interface is upward-compatible from 410X to 4110B terminals if common terminal firmware features are supported. This compatibility allows easy portability of applications from low to high-end terminals without loss of software investment.

With a local version of PLOT 10 IGL, existing IGL-based host programs can be run locally on 410X and 4110B terminals and easily moved to other Tektronix terminals (such as 4010 or 4020 Series). The user can thus choose where an application will run most efficiently -- on the host, the terminal or a combination of the two.

### Series-Wide Compatibility

Local Programmability runs on all 4110B Series terminals and on the 4170. The recommended system configuration includes a minimum of 256 kbytes of RAM. For program development the terminal needs two disk drives, although only one drive is needed to run programs locally.

## CHARACTERISTICS

### GENERAL INFORMATION

**Memory Requirements** — 256 kbytes.

**Equipment Requirements** — 4110B Computer Display Terminal or 4170 Local Graphics Processing Unit supporting 410X Series Computer Display Terminals. Dual disk functionality provided by any of the following: dual floppy disk drives, floppy disk and Winchester drive. Requires at least one floppy for 4110B's. 4170 has two floppy disks standard. Program execution requires at least a single disk drive and sufficient memory to run the program.

### INCLUDED ACCESSORIES

Blank floppy disk(s) user manual, programmer reference manuals.

## ORDERING INFORMATION

**Note: Prices are approximate depending on option.**

**4100P01** FORTRAN, CP/M-86 and DTI (CP/M includes the Digital Research ASM-86 Assembler ..... **$1,000**

**4100P02** Assemblers (Intel ASM86 and Digital Research ASM-86), CP/M-86 and DTI **$1,000**

**4100P11** Intel FORTRAN-86. Requires 4100P01 or 4100P02 ..... **$500**

**4100P12** Intel ASM86. Requires 4100P01 or 4100P02 ..... **$500**

**4110P73** PLOT 10 Interactive Graphics Library. (Requires Option 21 or 24) ..... **$10**

**Option 21** — 2-D Graphics with Panels and Fonts .... **+$740**

**Option 24** — 3-D Graphics (SIGGRAPH/ACM Core Package). (Requires hard disk plus 512 kbyte memory) ..... **+$1140**

**PLOT 10** IGL Primary Command Set plus Panel Support are included with purchase of 4170 Local Graphics Processing Unit. For further upgrading, order Option 23 or Option 24 below.

**4170P73** PLOT 10 Interactive Graphics Library ..... **$10**

**Option 23** — Segment Support (Requires hard disk plus 512 kbyte memory) ..... **+$940**

**Option 24** — 3-D Graphics (SIGGRAPH/ACM Core Package) (Requires hard disk plus 512 kbyte memory) ..... **+$1140**

**Tektronix offers user training on Local Programmability. For further information contact the Customer Training Registrar at (503) 685-3808 or your nearest Tektronix sales office.**

## PLOT 10 GRAPHICS SOFTWARE

Tektronix has been setting graphics standards for over a decade. Our new products reflect the implementation of the evolving international standards and the concepts that underlie those standards—software portability and device independence. The goal is to protect your software investment and provide a hardware growth path, and Tek software is designed to meet your changing needs.

Tektronix offers PLOT 10 products to make that goal a reality. PLOT 10 software takes advantage of the graphic capabilities of the 4010, 4100, and 4110 Series computer display terminals together with our color copiers.

PLOT 10 includes applications software as well as powerful tools to build applications to suit your specific needs.

### Software Support

When you buy Tektronix software, you are also investing in the people and services behind the product. A SSS (Software Subscription Service) provides current releases of Tek licensed software products, updates to the documentation, along with additional information on applications and enhancements. The TAS (Technical Assistance Services) are designed to supplement your own resources and to provide training as well as short-term consulting during your software implementation. These combined programs help you get maximum benefit from your Tektronix software products.

Product overviews and specification data follows. We invite you to ask your local Tektronix Sales Engineer for a demonstration. Or, simply indicate your interest on the enclosed reply card.

### PLOT 10 APPLICATIONS SOFTWARE

PLOT 10 application software has been built to take full advantage of the powerful features included in the 410X and 411XB Series of terminals.

### PLOT 10 Computer-Aided Drafting Software (TekniCAD)

Tektronix Computer-Aided Drafting Software (TekniCAD) is an interactive drafting package for automating a full range of drafting tasks. Based on the high-performance capabilities of the Tektronix 4100 and 4110 Families of graphic terminals, TekniCAD improves productivity by reducing the time spent creating and modifying drawings. Since the software was designed for office and drafting room operation, special electrical or environmental facilities are unnecessary. While adhering to ANSI Y14 and ISO international standards, TekniCAD can be easily adapted to current company drafting standards and practices.

PLOT 10 TekniCAD employs English Language prompts and either on-screen menus or tablet menu input to speed and simplify the creation and editing of technical drawings.

### Drawing Geometry

The geometric portion of a drawing is constructed using three item types (points, lines and arc/circles) and symbols.

### Symbols

May consist of any combination of lines, arcs, notes and symbols. They may be created as original objects or may be selected from items in a drawing.

### Annotation

Arrows, crosshatching, notes, dimensions and other annotation can be added to enhance or describe drawing geometry.

### Environmental Parameters

TekniCAD allows the user to set environmental parameters that apply to the drawing. These parameters include: dash type, pen assignments, level parameter, arc smoothness, text formats, keyboard and cursor control, and drawing units.

### Workset Functions

TekniCAD's Workset Functions will group drawing items so that they can be manipulated as a unit.

### Drawing Management

A drawing file contains all the geometry, symbols, annotation, and environmental parameters associated with a drawing when it was saved. Drawings may be saved, restored, or merged into other drawings.

### Plot Operations

PLOT 10 TekniCAD includes support for most major plotters available today. This means TekniCAD can output an entire drawing or selected portions of a drawing on a pen-plotter.

### CAD Interfacing

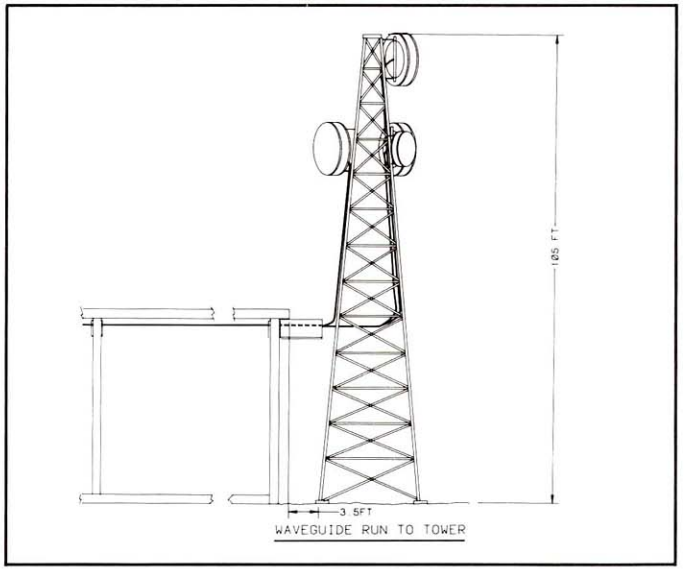
As an additional aid in integrating PLOT 10 TekniCAD into already existing CAD environments, and to interface to other major CAD software and turnkey systems, an I.G.E.S. (Initial Graphic Exchange Standard) interface is available. This transfer utility provides the ability to read and write industry standard I.G.E.S. format files with TekniCAD.

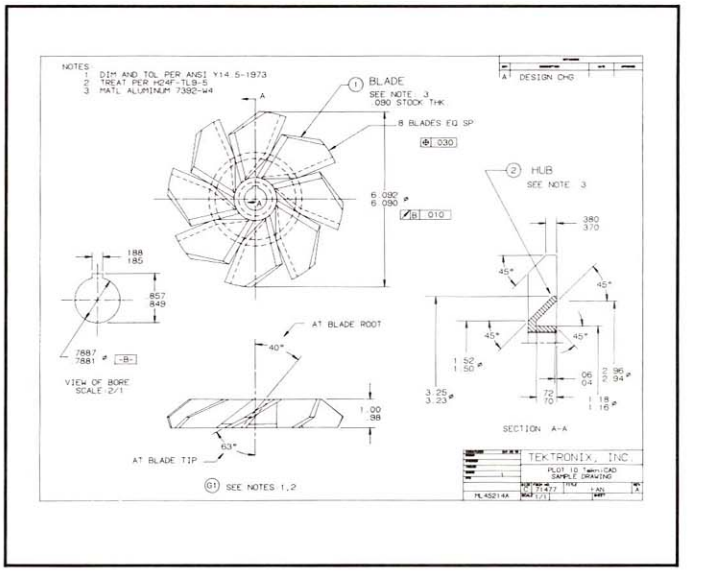
PLOT 10 TekniCAD Operates in a variety of computing environments to suit your requirements. Current installations include: DEC VAX computers with the VMS Operating Systems, Tektronix 6000 Family of Intelligent Graphics Workstations and under C/PM-86 in the Tektronix 411XB Computer Display Terminal and 4170 Local Graphics Processing Unit.

PLOT 10 TekniCAD provides draftsmen with a powerful tool, operating either locally or in a host-connected environment. Its complete set of features make PLOT 10 TekniCAD the solution for many drafting environments.

### PLOT 10 STANDARD TOOLS

PLOT 10 consists of three software libraries, each optimized for different graphics applications: Terminal Control System, Interactive Graphics Library, and PLOT 10 Graphical Kernel System.



**Peripheral Support for Device-Independent Graphics**

PLOT 10 products are packaged with device drivers for graphics hardware products; applications can be written without concern for the physical attributes of a device because the specifics reside in these device-dependent software modules. Many non-Tektronix products are advertising PLOT 10 compatibility; a special driver may not even be needed. PLOT 10 GKS includes drivers for Tektronix terminals, plotters and digitizing tablets. In addition, a device driver model and its documentation are provided offering the professional programmer a tool to develop drivers for non-Tek devices. PLOT 10 IGL also includes a full complement of device drivers to support the entire 4100 and 4110 lines.

**Software Portability**

Portability has always been the ultimate goal of the graphics standards efforts. Now it is not only possible to transport applications to a variety of host computers, but it is also possible to move applications to workstations using local programmability. Implementations of PLOT 10 TCS (the Terminal Control System that provides the basic graphics building blocks) and PLOT 10 IGL are available locally on 4100 series units. Options add advanced capabilities to the local version of IGL including line smoothing and 3-D graphics routines providing the power of mainframes computer graphics with the benefits of local programmability. An important feature of local programmability means enhanced interactivity at local processor speed rather than data communication line rates.

Existing applications on the host can be downloaded and run locally, thereby increasing interactivity and saving storage costs.

**PLOT 10 TCS (Terminal Control System) & AG-II (Advanced Graphing II)**

A composite of FORTRAN IV subroutines, TCS contains the basic building blocks for all graphic operations. Anything that can be displayed graphically can be managed by TCS. Its proven uses range from simple business graphs and forecast diagrams to contour maps of electron densities, interactive design of electrical circuit boards, and complex architectural renderings. Several data sets can be displayed on-screen at once by using the system's windowing functions, or graphics can be superimposed in the same screen area. It permits modular as well as system independent programming, and supports such basic graphic functions as windowing, clipping and rotation.

Advanced Graphing II Software is a Versatile Terminal Control System module to graph your data using a powerful set of FORTRAN IV subroutines. AG-II combines simplicity of use with highly flexible subroutines to let a programmer tailor the size, shape and format of graphs, by specifying more than 40 graphic elements. AG-II is as much a boon to the new user as to the expert. By using the system's built-in default determinations, you can supply as few as two subroutine calls to produce a full-screen graph properly scaled and annotated.

**PLOT 10 GKS (Graphical Kernel System)**

The PLOT 10 Graphical Kernel System (4000P70) is a FORTRAN '77 implementation of GKS at level 2B. GKS is the first international standard for computer graphics with language binding to FORTRAN '77. An application written for one version of GKS will run on any other of the same or higher level. GKS is device independent using device drivers to adapt to the display at hand. Colored lines, panels, multiple text fonts and graphic segments are included in PLOT 10 GKS. Each display surface, or workstation to GKS, may have its own set of attribute bundles. A programmer will find it easier to produce applications requiring interaction with separate windows and viewports with the tools in GKS. A metafile concept is included for storage and retrieval of drawings in a device independent manner. New 2-D applications will benefit from the strong engineering of this product, designed to meet the specifications of the first international graphics standard.

**PLOT 10 IGL (Interactive Graphics Library)**

PLOT 10 IGL is a uniquely modular system of I/O, device drivers, primary commands and advanced feature support that lets the user move at will among any Tektronix display devices or technology. The structure of PLOT 10 Interactive Graphics Library follows the concepts suggested in the ACM/SIGGRAPH study on a core standard for computer graphics. Advanced options such as Line Smoothing, Color Panel Support, Graphics Text Composer, Segments and 3-D graphics may be added. Device drivers are included in PLOT 10 IGL for 4020, 4010, 4110, and 4100 Series terminals. Subsets of PLOT 10 IGL features may be generated from our standard configurations to better match specific application requirements. Host computer and display device independence attributes of PLOT 10 IGL make it an excellent choice for 3-D graphics applications.

**Local or Host**

PLOT 10 GKS is available in ANSI FORTRAN '77 source form. PLOT 10 TCS, and PLOT 10 IGL are available in FORTRAN source form for host mainframe computers or in object code form to run on 4100 and 4110 Series terminals with CP/M-86.

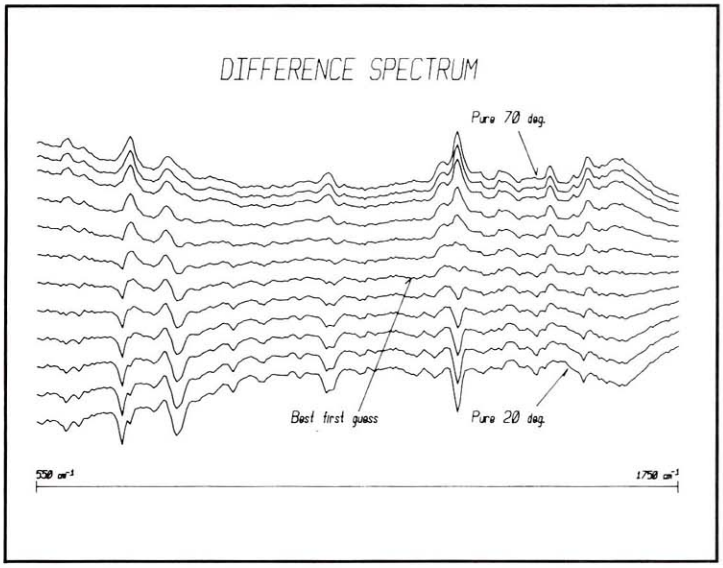
**ORDERING INFORMATION**

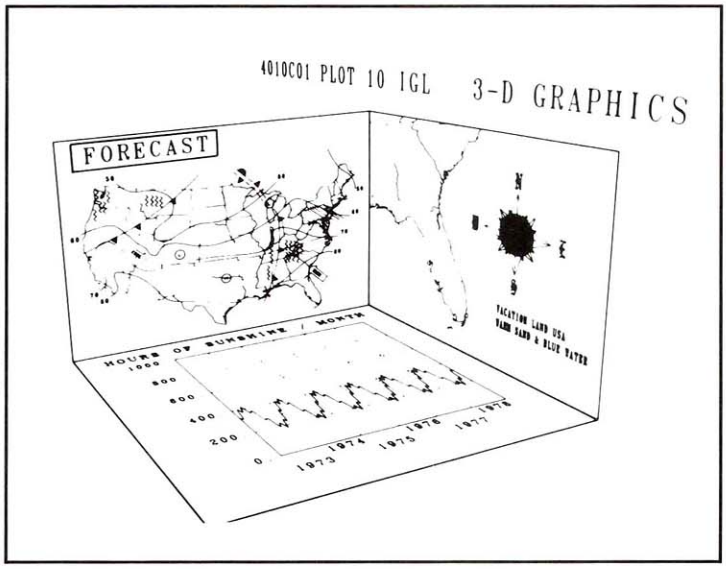
**Note: Prices are approximate depending on options.**

**4000P70** — PLOT 10 Graphical Kernel System ..... **$8,000**
**4100P30** PLOT 10 Computer-Aided Drafting C/PM-86 . **$2,200**
**4100P31** PLOT 10 TekniCAD/IGES Utility C/PM-86 ..... **$600**
**4000P35** PLOT 10 Computer-Aided Drafting Tektronix 6000 Family ..... **$4,000-$8,000**
DEC VAX with VMS ..... **$12,000-$16,000**
**4010A01** — PLOT 10 Terminal Control System ..... **$3,000**
**4010A15** — PLOT 10 TCS/IGL Bridge ..... **$500**
**4663A01** — PLOT 10 Utility Routines ..... **$750**
**4010C01** — PLOT 10 Interactive Graphics Library ..... **$4,000-$17,000**
**4010C02** — PLOT 10 Preview Routines ..... **$1,000**

**Tektronix offers user training classes on PLOT 10 IGL. For further information, contact the Customer Training Registrar at (503) 685-3808, or your nearest Tektronix office.**

**PLOT 10 GKS classes begin January 1985.**



VRIS (VR Information Systems, Inc.,) A wholly owned subsidiary of Tektronix, Inc., is the technological leader in layout software for design of VLSI circuits and in software for design of printed circuit boards.

MERLYN-G® Automated Layout System is the standard of comparison in the layout phase of the VLSI design process. Using sophisticated placement and routing algorithms the MERLYN-G slashes the time normally associated with the design of VLSI circuits. With the MERLYN-G, 100% of the layout function is automated and allows the design engineer to layout major array technologies using almost any array topology and any set of design rules.

The MERLYN-G offers expandable design capacity up to 10,000 gates, automated connectivity and design rule verification, and interactive graphical layout editors.

MERLYN-PCB® Printed Circuit Board Design System applies the same technological sophistication of the MERLYN-G to the entire design process of printed circuit boards. From schematic capture, through interactive placement, autoplacement, autorouting, wiring optimization, design documentation, film tooling and CAM interfaces the MERLYN-PCB is the complete solution to PCB design problems.

MERLYN-G and MERLYN-PCB are the products of VR Information Systems, a pioneer in circuit design tools since 1976.

VR Information Systems not only provides the best in VLSI layout tools and PCB design systems, but also extensive support and training services for its design products, including formal classroom instruction, demonstration exercises, applications assistance, periodic system updates, and complete documentation.

## MERLYN-G®

**Fully Automatic Placement and Routing**

**Array Style and Technology Independence**

**Highly Transportable, Written in FORTRAN 66**

**Expandable Capacity (100 Gates to 10,000 Gates)**

**Automatic Connectivity and Design Rule Verification**

**Interactive Graphical Placement and Wiring Editors**

### Automated Gate Array Layout

MERLYN-G slashes the time normally associated with gate array layout. It is a fully automated physical layout system for personalizing gate arrays. It automatically performs all of the layout functions such as cell/macro placement, routing, and wire path optimization using sophisticated state-of-the-art algorithms. Additionally, MERLYN-G has graphical editing facilities that allow the designer to interactively modify the layout.

MERLYN-G provides a variety of benefits to the gate array designer including:

- Rapid Turn-Around of Designs
- Consistent Application of Design Rules
- Support for new array styles and technologies
- Strong technical support, maintenance, and ongoing enhancements

### Fully Automatic Placement and Routing

The MERLYN-G layout system is truly an automatic system. As long as a design does not exceed the autoroutable cell utilization limit (typically 70% to 85% for an average array), no designer intervention in the layout process is required. Available cell utilization can be increased to greater than 90% when interactive editing techniques are used (depending on the complexity of the circuit).

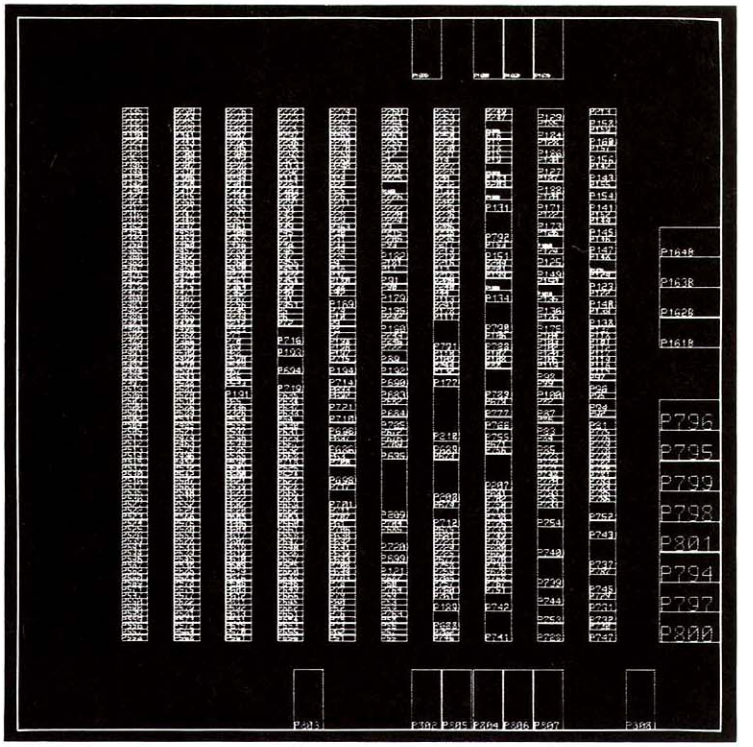
### Array Personalization Process

MERLYN-G uses a reference data base to store individual cell/macro descriptions and the general array specifications. The actual array personalization information (i.e., circuit specification) is entered as a free-format text file. The file can be automatically generated from a commercially available schematic capture system, or it can be created manually with a text editor. The MERLYN-G PREPROCESSOR combines the circuit specification with the relevant reference information to produce a machine-readable design file which can be manipulated by MERLYN-G.

MERLYN-G calculates a suitable placement for the cells used in the array.

MERLYN-G has a variety of tools to perform cell/macro placement and placement improvement functions. There are initial placers, automatic placement improvement tools, and interactive graphical placement editors. MERLYN-G placers initially locate cells/macros on the array and then rearrange their locations to enhance routing completion.

**Placement**




*Example of 100% auto-placed gate array, showing optimum placement of cells/macros for enhanced routing completion. No manual intervention was required.*

**Array Style and Technology Independance**
MERLYN-G has a proven track record in laying out the major array technologies. It supports almost any array topology using any set of design rules. Further, VR actively maintains active technical liaison with the major array vendors to ensure that MERLYN-G will continue to support the latest technology.

**Highly Transportable**
The MERLYN-G system is a highly transportable system written in ANSI standard FORTRAN 66. Both object and source code (United States only) licenses are available. The system is currently installed and running on superminis (DEC/VAX, HARRIS, PRIME) as well as mainframes (IBM, NAS, Amdahl).

**Expandable Capacity (100 Gates to 10,000 Gates)**
The MERLYN-G system has a modular configurable architecture that allows the designer to expand the capabilities of his system in step with his needs and expanding computer power.

**Automatic Connectivity and Design Rule Verification**
MERLYN-G has special facilities for verifying net connectivity and testing for shorts or design rule violations.

**Extensive Support and User Training**
MERLYN-G training is performed at the user's site and includes formal classroom instruction, demonstration exercises, and hands-on assistance with the user's own design problems. Optional sustaining technical support is available including periodic system updates as well as access to VR's customer support staff.

**System Environment**
The MERLYN-G system currently runs in a variety of hardware and operating system environments. The following specifications describe the required operating environment.

COMPILER ..... FORTRAN 66
PHYSICAL MEMORY ..... 2 Mb minimum
OPERATING SYSTEM ..... Virtual (4 Mb to 12 Mb)
DISK CAPACITY ..... 140 Mb or more
CODE TRANSFER ..... Magnetic Tape
GRAPHICS TERMINALS ..... Tektronix
PLOTTERS ..... Versatek, Nicolet, Tektronix, Zeta, Gerber, etc.

After layout, MERLYN-G generates check plots, descriptive reports, and data files compatible with major manufacturing systems (e.g. CALMA, etc.

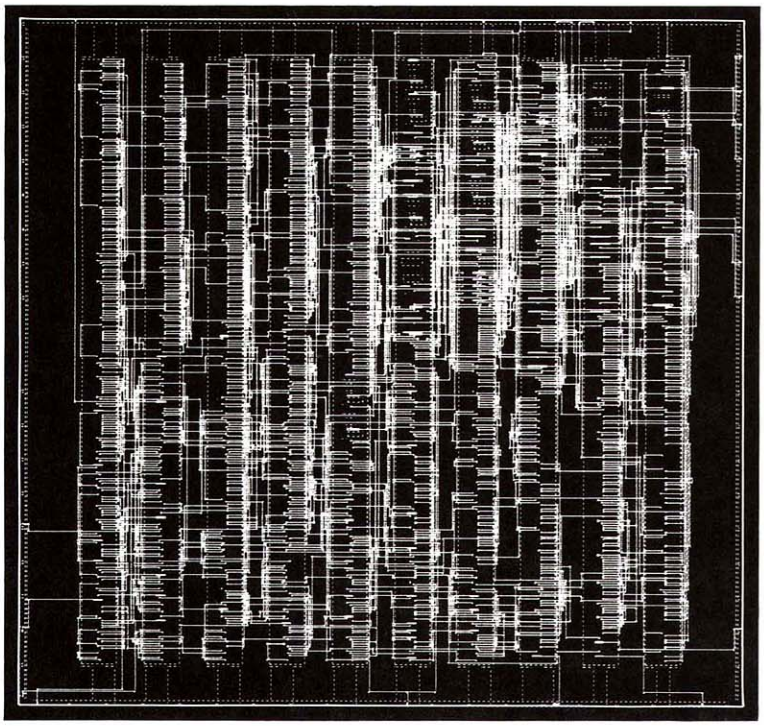
For further information about the MERLYN-G gate array layout system as it applies to your particular design needs, please contact VR Information Systems, Inc. (a wholly owned subsidiary of Tektronix, Inc.)

**VR Information Systems, Inc.**
**12212-A Technology Blvd.**
**Austin, Texas 78727**
**Phone: (512) 331-1303**
**TLX: (910) 874-2052**



MERLYN-G has a variety of routing systems to accomodate various array styles. The BASIC CHANNEL ROUTER is used to route simple row/column style arrays. The ADVANCED CHANNEL ROUTER routes complex arrays with intersecting channels. Also, there are special routing tools for particularly difficult probems, including the MAZE ROUTER for barrier strewn topologies and the RIPUP AND RETRY ROUTER for isolated nodes.

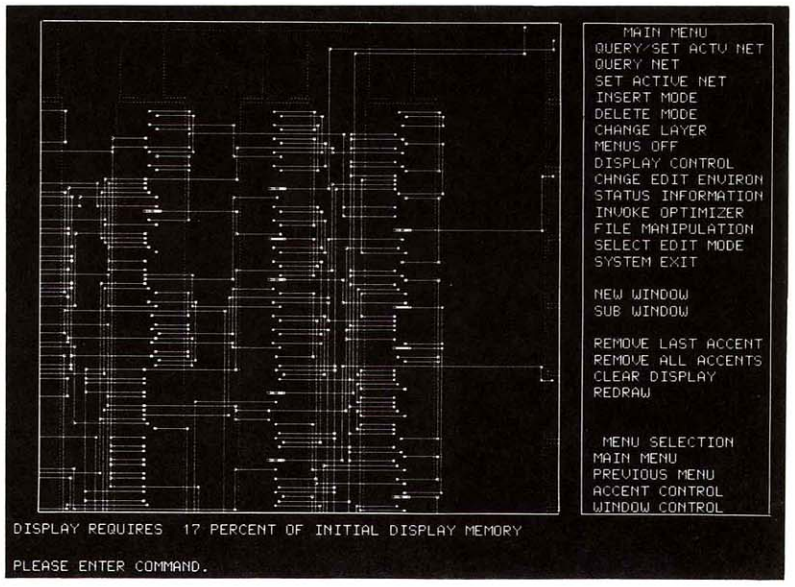
**Routing**



*Example of 100% auto-routed gate array (using placement shown in previous illustration). No manual intervention was required.*

MERLYN-G has dynamic on-line layout editing facilities for both placement and wiring. A GRAPHICAL PLACEMENT EDITOR allows the designer to interactively modify placement, and A GRAPHICAL WIRE EDITOR allows the designer to interactively modify wiring.

**Interactive Editing**




*This particular example illustrates the capabilities of the interactive graphical wire editor MERLYN-G offers to the designer.*

NEW

PCB DESIGN SYSTEM

## MERLYN-PCB®

**Schematic Capture/Implicit Schematic Back Annotation**

**Continuous Design**

**Automatic/Interactive Placement, Routing (to 1 mil) and Packaging**

**Board Outlines up to 32.7 Inches Square**

**User Command with On-Screen Menus, Keyboard, Graphic Tablet and Puck**

**Manufacturing Output and Printed Reports**

**Reentrant Autoplacer/Autorouter**

**Partial Placement/Partial Routing Options**

**Interactive Stitching Simultaneous to 16 Layers, Real-time Checking**

**Diagonal Autorouting, Stitching**

**Grid Size Changes During Autorouting, Stitching**

**CAM Package**

### Cost Effective

MERLYN-PCB offers design engineers an integrated, interactive, easy-to-use system for PCB design. This system can realize payback in as few as three designs, clearly making it the most cost effective PCB design system available.

At the heart of the MERLYN-PCB system is PC-BASE® which contains all of the data needed to layout a PCB (including the electrical and mechanical characteristics of the components), the board geometry and layout rules, as well as the circuit schematic data. Since all of the data is stored in a single data base, you do not need to translate file formats or provide special interfaces when advancing through layout phases.

All of these features are contained in one of the best price-performance packages available today.

### User Friendly, Menu-Driven Interface

The MERLYN-PCB system dynamically enforces all predefined drafting standards. Assist functions are supported to help the designer with the schematic input. It automatically routes the schematic connections (including support for bus connections). When a symbol for a logical device is moved, MERLYN-PCB automatically reroutes the connections. The system also features implicit schematic back annotation, which checks the board design back to the schematic. MERLYN-PCB has been designed to speed the schematic capture process by the inclusion of a 3-bend autorouter.

The MERLYN-PCB package includes a standard library of more than 400 commonly used electrical components. The conversational library maintenance system allows definition of other devices as needed, and up to four personal libraries may be created.

### Schematic Analysis and Netlist Generation

MERLYN-PCB provides checks for completeness and for common electrical errors. It can also perform loading analysis on the circuit. After all checks are completed, MERLYN-PCB automatically generates the netlist for use in placement and routing phases of the layout. This netlist can be used as input to a logic simulator or an automatic test pattern generator.

### Automatic/Interactive Placement

MERLYN-PCB supports both interactive and automatic component placement. The system offers reentrant features during autoplacement, allowing the designer to automatically place all of the components, then manually relocate components as needed. MERLYN-PCB supports a NET GRAPH display that visually shows the connections between components to help the designer find the best component locations.

A density analysis display shows the minimum spanning tree network (as line-of-site connections) on the components. This helps the designer locate areas of potential wiring congestion.

The placement optimization system finds the optimal component placement for a circuit based on the shortest interconnection wire length.

### Automatic Routing

MERLYN-PCB has a fully automatic router that generates wiring on up to 16 different layers. It can generate multiple width traces, route off or on grid, generate diagonal (45 degrees) wiring and "T" (Steiner) connections. The router is a design-rule-driven system, with rules being specified in real dimensions, not just in terms of a wiring grid. It uses a very persistant wave expansion algorithm with a variety of tunable attributes.

### Multilayer Interactive Wire Editing

MERLYN-PCB has an advanced interactive wire editing facility for making design changes and completing boards that are not 100% automatically routed. Included is the Edit and Adjust Function which moves traces and components aside to allow for new wiring. The Strip Net Utility provides the designer with the option of removing designated wiring. Net Graphs may be displayed that highlight the wiring associated with a given net. Rapid panning and zooming display capabilities and highlighting functions are other valuable features of MERLYN-PCB.

### Board Optimization

The wiring optimization package improves the manufacturability of a layout. MERLYN's via reduction capability reduces the number of vias required to complete the net, and contains a hanging wire removal program that eliminates unused paths. MERLYN-PCB also has a special acute angle removal capability that reduces sharp bends in the wire paths.

### Complete Design Documentation and Artwork/CAM Package

MERLYN-PCB produces well designed, standard outputs directly from the MERLYN-BASE Central-Database. CAD/CAM outputs are selected from a series of application menus which control the output process and ensure that computer accuracy is maintained.

### System Environment

The MERLYN-PCB system currently runs in two computing environments, on the VAX-750/780 supermini or on the AT&T 3B2 minicomputer. Both environments will utilize the Tektronix 4100 Series graphics terminals as input devices.

### CHARACTERISTICS

**PARAMETER MAXIMUMS**

**Vias Per Design** — 6250*1.
**Vias Per Net** — 2000.
**Components Per Design** — 512*1.
**Components of the Same Type Per Design** — 512*1.
**Preplaced Components Per Design** — 256.
**From-Tos Per Design (Pin-To-Pin Connection)** — 5000*1.
**Nets Per Design (Unique Names)** — 1200*1.
**Pins Per Design (Used and Unused)** — 5000*1.
**Pins Per Component Type (Including Connectors)** — 256.
**Pins Per Gate** — 256.
**Pins Per Connector** — 256.
**Pins Per Net** — 500*1.
**Gates Per Design** — No Practical Limit.
**Gates of the Same Type Per Design** — 512*1.
**Gates Types** — No Practical Limit.
**Gates Per Component** — 256.
**Gates Per Net** — No Practical Limit.
**Void Areas** — 200.
**Line-Vectors on Signal Layers** — 15,000.
**Board Size** — 32.7 x 32.7.
**Number of Line-Vectors Per Net** — 2000*1.

**1 Can be recompiled to be higher if required.*

For further information, about the MERLYN-PCB layout system as it applies to your particular design needs, please contact VR Information Systems, Inc. (a wholly owned subsidiary of Tektronix, Inc.)

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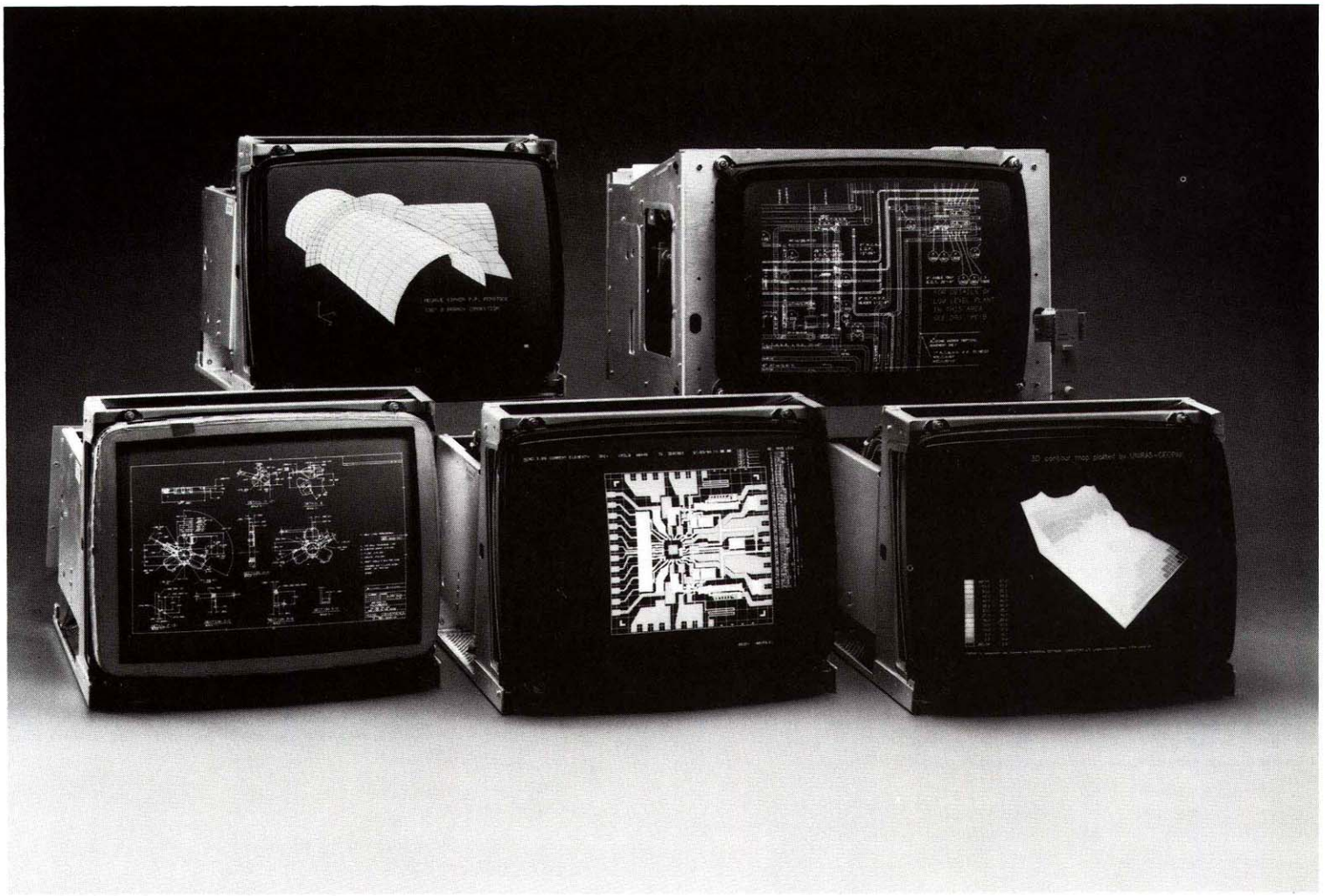


*GMA Family*

# DISPLAY PRODUCTS

**Reliability, Performance, Value, Support**
As a world leader in display technologies, Tektronix is committed to building lasting OEM relationships and supporting its OEM customers with continuing product developments. We introduced a total of five new 19-inch raster monitors this year, including monitors employing two patented breakthroughs; a high-resolution color monitor with automatic convergence (GMA304) and a monochrome monitor with a low-capacitance electron gun that yields very high video bandwidth with low power consumption (GMA201).

Our comprehensive OEM support program includes OEM service agreements and capabilities throughout the United States and the world; interface assistance and applications engineering and documentation; and OEM pricing, terms and conditions to help you be competitive.

We know that your systems can only be as reliable as the components that go into them. For that reason, we place a premium on dependability. We produce products that will keep you and your customers satisfied and service costs down.

**Flexible Product Families**
Tek offers its OEM products as families rather than as a collection of individual products, to give the OEM greater flexibility in meeting changing market requirements. The three Tek display product families are:

**Small-Screen X-Y Monitors**
Tek's small-screen monitors are proven performers in diverse applications ranging from medical imaging to military systems, and provide crisp, high-resolution presentation of waveform or image data.

**Large-Screen DVST Displays**
Another Tek innovation, the Direct View Storage Tube, enables information to be written and stored on a CRT without constant image refresh. All permit real-time motion, rotation, scaling and selective erasure before storage.

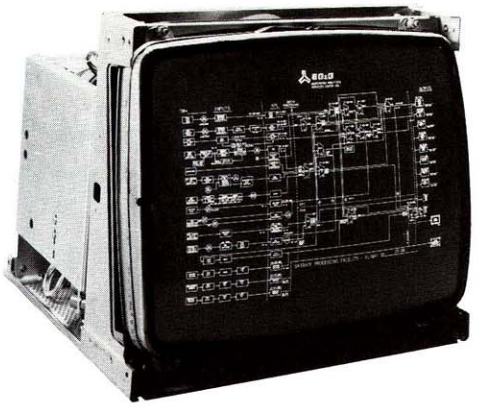
**Large-Screen Raster Displays**
This year brings five new raster displays to Tektronix' portfolio of display products. The GMA family of raster displays spans the spectrum from monochrome to color and medium to very high resolution. Features include CRT guns of precision-in-line, delta and low-capacitance design; dynamic and autoconvergence correction of the color beam alignment; contrast enhancement panels to optimize viewability; and highly-tuned electronic circuits for accurate and stable images. When enclosed in optional Tektronix-designed cabinets, each of the displays conforms to world-wide EMI requirements. These raster displays fit application needs ranging from process control to the high-performance requirements of imaging and computer-aided design.

Consider the advantages of working with Tektronix: a wide selection of display technologies and models covering the spectrum of performance, all within our display product families. Exceptional performance. Built-in reliability. Measurable value. Extensive service and support. Your local Tektronix OEM Representative will show you how to profit from a partnership with Tektronix.

**Special pricing, terms and conditions are available to qualified OEMS. Contact your local Tektronix representative for complete information.**

NEW

COMPUTER DISPLAY MONITORS



GMA201

## GMA201

### Monochrome Raster Display Monitor

**High-Resolution Video for the System Builder**

**Bright, Stable Noninterlaced 60 Hz Refresh**

**200 MHz Video Amplifier Bandwidth**

**ROM-based Dynamic Focus**

**Modular Construction for Easy Field Service**

**The GMA201 is a member of Tektronix OEM display product family that provides unparalleled raster scan video performance.**

Key features of the GMA201 monochrome display include 1536 vertical by 2048 horizontal addressable pixels, digitally-adjusted focus, astigmatism correction, contrast enhancement panel, and a crisp, well-focused beam at all points on the screen. A patented low-capacitance gun structure was developed to address the requirements for small uniform spot size, rugged construction and low power dissipation.

The GMA201 is well-suited to system builders in the fields of gray-scale imaging, CAD/CAM, computer-aided publishing, document retrieval, and related technical applications that require extremely high performance. The GMA201 complies with worldwide safety and emissions standards.

### CHARACTERISTICS

#### DISPLAY

**Addressable Area** — 267 mm x 356 mm (10.5 in x 14 in).

**Addressable Resolution** — 1536 pixels x 2048 pixels at 60 Hz noninterlaced.

**Aspect Ratio** — 3:4 nominal.

**CRT Orientation** — Long axis horizontal.

**Brightness** — 100 cd/m2 (30 fL) with installed contrast enhancement filter.

**Geometric Distortion** — Incremental nonlinearity: ±3% at 25°C. Positional Accuracy: ±1% of image height. Peak-To-Peak Line Variation: ±5%.

**Spot Size** — 7.5 mils (0.19 mm) center screen (maximum). 9.0 mils (0.23 mm) corners (maximum).

**Focus, Astigmatism** — Dynamically controlled, digitally adjusted using ROM look-up table.

**Phosphor Type** — WW (P4).

#### VIDEO AMPLIFIER

**Bandwidth** — Dc to 200 MHz (−3 dB)

**Pulse Response** — $T_r \leq 1.75$ ns. $Tf \leq 1.75$ ns.

#### VIDEO INPUT

**Interface** — Linear, dc coupled.

**Impedance** — 50 Ω.

**Recommended Input Signal Rise and Fall Time** — ≤1 ns.

**Level** — Black = 0 V, white = +1.0 V.

**Maximum Non-Destructive Input** — +5 V, −2 V.

#### SYNC INPUTS

**Interface** — TTL Compatible, falling-edge triggered.

**Horizontal Sync** — 93.6 kHz, ±2%.

**Vertical Sync** — 50 Hz or 60 Hz ± 3 Hz. Factory-calibrated to 60 Hz.

**Vertical Retrace Time** — ≤ 250 μs.

**Horizontal Retrace Time** — ≤2 μs.

#### AC POWER

**Range** — 87 V to 128 V, 174 V to 256 V, all at 48 Hz to 63 Hz.

**Power Consumption** — 150 W maximum.

#### CONDITION INDICATORS

Scan fail, low-voltage power supply, high-voltage power supply.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 447 | 17.6 |
| Height | 389 | 15.3 |
| Depth | 485 | 19.1 |
| **Weight** | **kg** | **lb** |
| Net | 25.0 | 55.0 |

#### INCLUDED ACCESSORY

Service Manual.

### ORDERING INFORMATION

**GMA201** Monochrome Raster Display Monitor ..... **$3,675**

**Option 23*1** — Cabinetry and CRT Bezel ..... **+$870**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

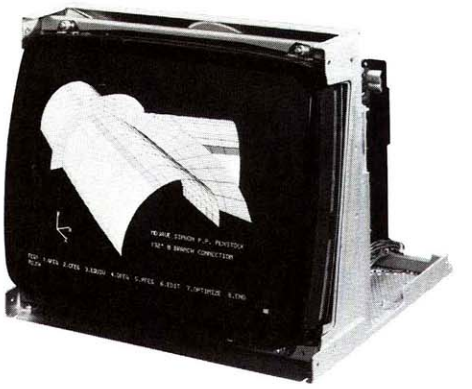
**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

**Option A5** — Switzerland 220 V/10 A, 50 Hz

**1 Option 23 includes a standard North American 115 V power cord. Option 23 is required to order A1-A5 power cords.*



GMA301

## GMA301/302/303/304

### Color Raster Display Monitors

**High-Performance 19-Inch Color Raster Display Monitors**

**Dynamic Convergence**

**Bright, Stable Noninterlaced 60 Hz Refresh**

**Modular Construction for Easy Field Service**

The GMA300 Series of Color Raster Display Monitors offers OEM System Builders High Performance and a Range of Resolution in Modular Product Packaging.

The Tektronix GMA Series offers OEMs a family of raster displays to fit any application need and budget. The GMA300 Family includes: the GMA301, with 525-line noninterlaced field and an addressable pixel matrix of 640 x 480; the GMA302 with an 800-line field with a 1024 x 768 matrix; and the GMA303 and GMA304, which offer a 1067-line field with a 1280 x 1024 matrix.
The GMA300 Series color displays are designed for system builders requiring high-quality, full-color 19-inch displays. The GMA300 family addresses a range of performance and market areas including CAD/CAM, cartography, process control, computer-aided publishing, and related technical applications.

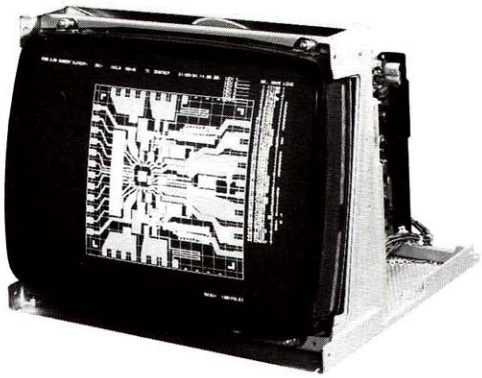
In addition to having a 19-inch screen, all family members operate at a flicker-free 60 Hz noninterlaced refresh rate. Display quality is further enhanced in the GMA301, 302 and 303 by dynamic convergence correction, which allows adjustment of the color convergence to ≤0.3 mm over the entire display area, and a precision-in-line gun CRT. The GMA304 incorporates Tek's patented autoconvergence which, at the push of a button, automatically adjusts the color convergence to ≤0.25 mm over the entire display quality area. To reduce viewing fatigue, an antireflective coated neutral density contrast enhancement panel is bonded to the CRT faceplate.



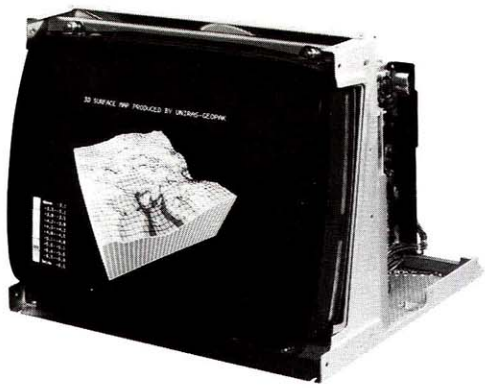
OEM terms available on these products.

NEW

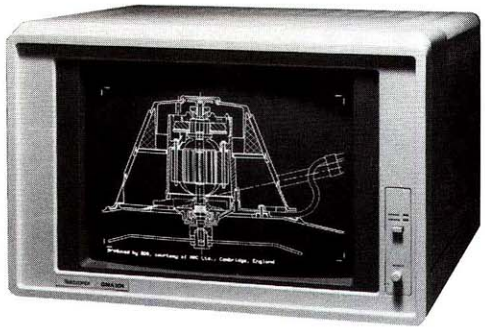
COMPUTER DISPLAY MONITORS



GMA302



GMA303



GMA304 *Option 23*

### Display Accuracy Sharpens Image

The high-voltage power supply in the GMA Series incorporates stringent voltage regulation to minimize raster size changes. Circuit accuracy and stability in the deflection system minimize geometric distortion and linearity errors. Power supplies are synchronized to the deflection system, eliminating image "swim."

### Modular Construction for OEM Flexibility

The GMA Series was designed with the OEM system builder in mind. The CRT and circuit boards are arranged in a compact, easily integrated open-frame sheet-metal chassis. Circuit modules can be removed in the field for less down-time and lower service costs. The monitors are designed to allow easy interfacing of power, degauses and brightness controls, allowing the OEM to use hardware and a mounting design of their choice. Because the GMA201, 301, 302 and 303 share a similar mechanical package, OEMs can upgrade their systems with minimal mechanical changes.

## CHARACTERISTICS

#### DISPLAY

**Addressable Area — 301:** 356 mm x 267 mm (14.0 in x 10.5 in). Addressable resolution is 640 pixels x 480 pixels. **302:** 356 mm x 267 mm (14.0 in x 10.5 in). Addressable resolution is 1024 pixels x 768 pixels. **303:** 343 mm x 274 mm (13.5 in x 10.8 in). Addressable resolution is 1280 pixels x 1024 pixels. **304:** 342.9 mm x 274.3 mm (13.5 in x 10.8 in). Addressable resolution is 1280 pixels. x 1024 pixels.

**Refresh Rate —** 60 Hz noninterlaced.

**Aspect Ratio — 301, 302:** 4.3 nominal. **303, 304:** 5.4 nominal.

**Convergence — 301, 302, 303:** ≤0.3 mm over the entire display area. **304:** ≤0.25 mm over the entire display area.

**Colorimetry (White) —** 9300°k.

**Intensity —** With contrast enhancement panel. White Luminance: ≥70cd/m² (≥20 fL) for the entire series.

**Black Level Stability — 301, 302, 303:** ≤5 cd/m2 (≤1.5 fL). **304:** ≤0.4 cd/m2 (≤0.1 fL).

**Geometric Distortion (304) —** All points within 3.43 mm (0.135 in) of true position. From 0°C to 40°C true position within 6.0 mm (0.236 in).

**Raster Size Variation — 301, 302, 303:** ≤0.25% from minimum to maximum luminance. **304:** ≤0.1% from minimum to maximum luminance.

**Positional Accuracy —** At calibration temperature, all points within 3.57 mm (0.14) in) of true position. Over specified operating temperature, all points within 7.14 mm (0.28 in) of true position on **301** and **302;** within 6.1 mm (0.24 in) on **303.**

**Incremental Linearity —** At calibration temperature: ≤3% error. Over specified operating temperature range: ≤5% error.

**Incremental Line Straightness —** At calibration tempeature: Peak-to-peak deviation ≤3% of measurement interval. Over specified operating temperature range: Peak-to-peak deviation ≤5% of measurement interval.

#### ELECTRICAL CHARACTERISTICS

**Video Amplifiers —**
**301** Bandwidth: ≤50 Hz to ≥30 MHz at −3 dB.
Pulse Response: ≤11.5 ns.
**302** Bandwidth: ≤50 Hz to ≥60 MHz at −3 dB.
Pulse Response: ≤5.8 ns.
**303** Bandwidth: ≤50 Hz to ≥90 MHz at −3 dB.
Pulse Response: ≤4.0 ns.
**304** Bandwidth: ≤50 Hz to ≥90 MHz at −3 dB.
Input Pulse Response: ≤1.0 ns.

**Video Signal Timing —**

| | 301 | 302 | 303 | 304 |
|---|---|---|---|---|
| Vertical Freq | 60 Hz | 60 Hz | 60 Hz | 60 Hz |
| Horizontal Freq | 31.5 kHz | 48 kHz | 64 kHz | 64 kHz |
| Vertical Retrace | 600 μs max | 600 μs max | 550 μs max | 550 μs max |
| Horizontal Retrace | 5 μs max | 5 μs max | 4.5 μs max | 4.5 μs max |

**Video Inputs —**
Interface **301, 302, 303:** Linear, ac coupled, BNC type.
Interface **304:** Linear, dc coupled, BNC type.
Impedance: 75 Ω.
Level: −0.5 V p-p minimum, 3.0 V p-p maximum (factory-calibrated for 1.0 V p-p).
Level: White level positive with respect to back porch.
Maximum non-destructive input: ±15 V, dc plus peak ac, momentary input: ±5 V, dc plus peak ac continuous input.
Sync **301** Interface: Composite input with green video.
Amplitude: 0.4 V peak-to-peak.
Level: Negative with respect to back porch.
Sync **302, 303, 304** Interface: Separate H-Sync and V-Sync inputs, BNC type.
Level: TTL-compatible.
Impedance: TTL-compatible (2 Schottky TTL loads).

#### INCLUDED ACCESSORY

Service Manual

## ORDERING INFORMATION

**GMA301** Color Raster Display Monitor **$4,020**
**GMA302** Color Raster Display Monitor **$3,675**
**GMA303** Color Raster Display Monitor **$4,345**
**GMA304** Color Raster Display Monitor **$9,240**
**Option 23*¹** — Cabinetry, CRT Bezel ..... **+$870**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

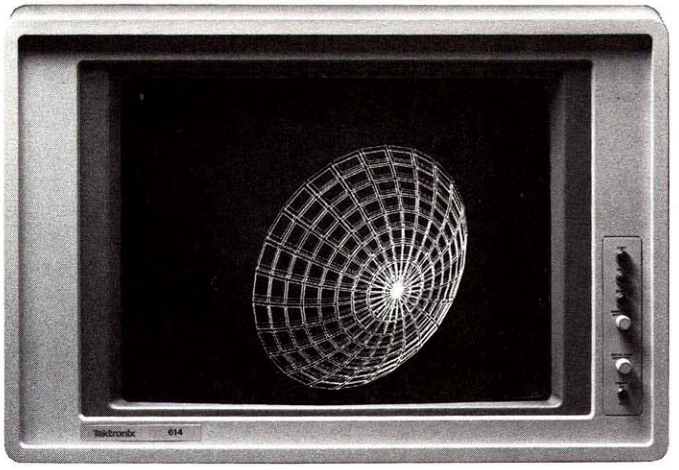
**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

**¹ Option 23 includes a standard North American 115 V power cord. Option 23 is required to order the Option A1-A5 power cords.*

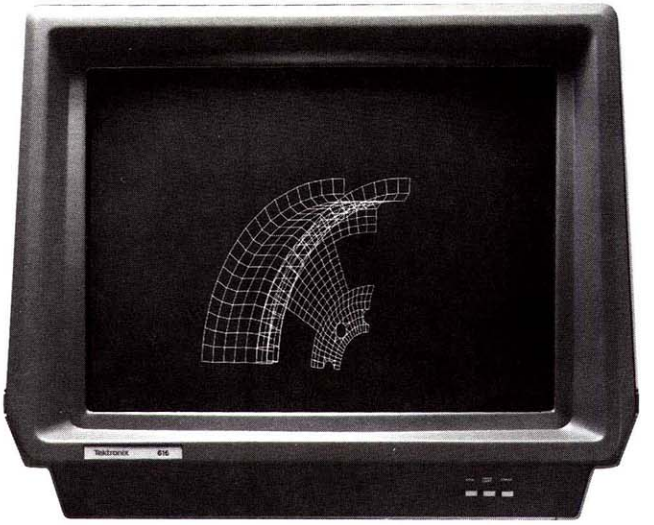
#### PHYSICAL CHARACTERISTICS

| Dimensions | GMA301, 302, 303 CRT 10°Tilt | | With Option 23 | | GMA304 Standard | | With Option 23 | |
|---|---|---|---|---|---|---|---|---|
| | mm | in | mm | in | mm | in | mm | in |
| Width | 447 | 17.6 | 553 | 21.8 | 548 | 21.8 | 584 | 23.0 |
| Height | 389 | 15.3 | 429 | 16.9 | 386 | 15.2 | 422 | 16.6 |
| Depth | 485 | 19.1 | 567 | 22.3 | 564 | 22.2 | 584 | 23.0 |
| **Weights** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** |
| Net | 25 | 55 | 34 | 75 | 41 | 90 | 52 | 115 |

614



616



## 614/616 Storage Display Monitors

**High Resolution Graphics**

**Combined Stored and Write Thru Mode**

**19 Inch and 25 Inch Diagonal CRT**

The 614 and 616 are high performance analog input bistable storage display monitors. This family of displays is capable of displaying alphanumerics and high resolution, high density graphics at a low cost. In the storage mode, graphic lines are sharp, stable, and flicker-free making it easy for the user to study the finer details of a design. The write-thru mode (a technique by which refreshed data appears on the screen at the same time as stored graphics), allows increased viewability, selective erase, interactivity, and dynamic motion with the same high resolution. Write-thru color is green on the 616 and yellow-orange on the 614. This permits rapid differentiation of working and stored information.

### APPLICATIONS

The 614 and 616 are well suited as a high-speed interactive graphics attachment to the IBM 3277 Model 2 Display Station, enhancing the capabilities of the overall system. The graphics attachment and software (RPQ7H0284 and P09013 from IBM) allows the display monitor to add a wide range of graphics capabilities to the station. A dual display station is thus configured with the IBM monitor displaying the alphanumeric data and the Tektronix storage monitor displaying graphics information and special symbols. The 614 and 616 are versatile displays and can be used in other environments which can benefit from productivity improvements offered by advanced storage display monitors with refresh capabilities.

## 614/616 Operations

All display functions are completely programmable and designed to interface to standard TTL level logic. The X and Y deflection amplifiers have differential analog inputs. A CRT antiburn circuit is provided to help protect against burning the CRT phosphor in the event that the beam is moving too slowly across the CRT with the Z-axis turned on or the X and Y deflection fails. If there is no screen activity for approximately two minutes, the screen brightness will be reduced to prolong CRT life. After thirty minutes of inactivity, the screen is automatically erased.

### CHARACTERISTICS

**The following characteristics are the same for the 614 and 616 unless otherwise noted.**

#### DISPLAY

**CRT Type** — Direct view storage.

**Dimensions** — 614: 48 cm (19 in) diagonal. 616: 63 cm (25 in) diagonal.

**Display Area** — 614: 26.7 cm x 35.6 cm (10.5 in x 14 in). 616: 49.0 cm x 36.2 cm (19.3 in x 14.25 in).

**Stored Writing Speed** — 614: 150 m/s. 616: 200 m/s.

**Refresh Writing Speed** — 614: 500 m/s. 616: 1500 m/s.

**Write-Thru Contrast Ratio** — ≥4:1.

**Max Z-Axis Repetition Rate** — 614: 1 MHz. 616: 2 MHz.

**Stored Luminance** — 614: N/A. 616: 13.7 cd/m² (>4 fl).

**Resolution** — Center Screen: 15.7 lines/cm (40 lines/inch). Screen Edges: 13.8 lines/cm (35 lines/inch).

**Positional Accuracy** — 614: ±1.25% of long axis. 616: ±2.5% of long axis.

**Stored Dot Writing Time** — 614: ≤5 μs. 616: ≤2 μs.

**Settling Time (Non linear operation; ≥1 cm deflection)** — 614: 3 μs +4 μs/cm to within 1 spot diameter.
616: 1 μs +2 μs/cm to within 1 spot diameter.

**Erase Time** — 614: 1.5 s ±20%. 616: 1.0 s ±12%.

#### POWER

**Line Voltage** — 614: 100 V ac, 120 V ac, 220 V ac, 240 V ac ±10%. 616: 90 V ac to 132 V ac and 190 V ac to 250 V ac (selectable).

**Line Frequency** — 614: 48 Hz to 66 Hz. 616: 48 Hz to 440 Hz.

**Power at 115 V ac, 60 Hz** — 614: 220 W maximum. 616: 350 W maximum.

#### PHYSICAL CHARACTERISTICS

| Dimensions | 614 | | 616 | |
|---|---|---|---|---|
| | mm | in | mm | in |
| Width | 584 | 23.0 | 686 | 27.0 |
| Height | 426 | 16.8 | 591 | 23.3 |
| Depth | 582 | 22.9 | 565 | 22.2 |
| **Weights** | **kg** | **lb** | **kg** | **lb** |
| Net | 46.0 | 100.0 | 68.0 | 150.0 |

#### INCLUDED ACCESSORIES

Power cord (161-0066-00); instruction manual.

### ORDERING INFORMATION

**614** Storage Display Monitor ..... **$9,200**

**616** Storage Display Monitor ..... **$14,375**

**Option 30** — Interconnecting Cable (to Allow Attachment to IBM 3277 Model 2) ..... **+$155**

**Option 38** — Blue Glass Filter (616 Only) ..... **NC**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

**Option A5** — Swiss 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 14**

**N1** — (614) Service Plan + 9 Months Service ..... **+$685**

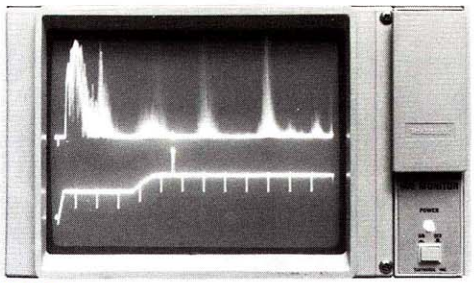
**N3** — (614) OEM Service Plan + 12 Months Service .. **+$910**

**N1** — (616) Service Plan + 9 Months Service ..... **+$855**

**N3** — (616) OEM Service Plan + 12 Months Service **+$1,140**

Tektronix offers compatible hard copy units that allow Graphic and Alphanumeric information to be copied from the storage CRT. See page 71 for a complete description on the 4611/4631 Hard Copy Units.

Special pricing, terms, and conditions are available to qualified OEM's. Contact your local Tektronix representative for complete information.



## 608 Monitor

### High Resolution with Ambient-Light Viewing

### Expansion-Mesh-Halo Suppression

### Excellent Gray Scale, High Brightness Display

The 608 is Tektronix' finest directed-beam viewing monitor. It is extremely well suited for high-performance display applications such as medical and military imaging and electronic instrumentation. The 608's high usable brightness, small spot size, and large screen give excellent direct-viewing capability. It produces detailed displays that are easy to read in high ambient light and produce quality photographs.

The special CRT design suppresses expansion-mesh halo, which ordinarily causes lower contrast and a "washed out" appearance that interferes with high-brightness gray-scale displays. Expansion-mesh-halo suppression results in a more readable display with subtle and accurate gray-scale images and detailed waveforms. In addition, imaging is critically sharp from corner to corner because of the dynamic focusing employed.

The wide deflection factor facilitates integration with a broad range of designs. An optional metal bezel lets you use heavy cameras, including those with motorized roll-film backs, without causing distortion, defocus, or light leaks.

In addition, optional full-differential inputs help reject unwanted common-mode signals such as ground noise and power-supply hum. Plus, the 608 can be ordered with gamma-correction for photographic applications. This option produces linear light-output changes with a linear change of Z-axis input, typically within 20 percent.

### CHARACTERISTICS

#### DISPLAY

**Type** — Flat-faced, electrostatic CRT.

**Dimensions** — 98 mm x 122 mm (3.9 in x 4.8 in).

**Phosphor** — GH (P31) is standard.

**Spot Size** — 0.25 mm (10 mils) at 170 cd/m² (50 fL); max brightness −240 cd/m² (75 fL).

#### VERTICAL AND HORIZONTAL AMPLIFIERS

**Bandwidth** — Dc to at least 5 MHz.

**Deflection Factor** — Adjustable 50 mV/div to 0.25 V/div. Option 22 (5X attenuator) extends deflection factor to 1.25 V/div.

**Input R and C** — 1 MΩ ±1% paralleled by <60 pF.

**X-Y Phase Difference** — One degree max to at least 1.5 MHz.

**Maximum Input Voltage** — ±100 V (dc plus peak ac).

**Linear Common-Mode Signal Range** — With Option 21 ±3 V. (Option 22 extends range to ±15 V.)

**Recommended Source Impedance** — ≤10 kΩ.

#### Z-AXIS AMPLIFIER

Z-Axis amplifier permits intensity modulation of the writing beam.

**Bandwidth** — Dc to 10 MHz over usable range.

Sensitivity range is adjustable from 0 V to +1 V to 0 V to +5 V for full-intensity control.

**Input R and C** — 1 MΩ ±1% paralleled by <60 pF.

**Linear Common-Mode Signal Range** — With Option 21 ±5 V.

#### AC POWER

**Voltage Ranges (±10%)** — 100 V ac, 110 V ac, 120 V ac, 200 V ac, 220 V ac, and 240 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Power** — 61 W maximum at 120 V ac.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 133 | 5.2 |
| Height (without feet) | 213 | 8.4 |
| Depth | 493 | 19.4 |
| **Weight ≈** | **kg** | **lb** |
| Net | 8.0 | 17.6 |
| Shipping | 10.4 | 23.0 |

#### INCLUDED ACCESSORIES

CRT graticule (337-2126-02); instruction manual; operator's manual.

### ORDERING INFORMATION

**608** Monitor (without handle, feet, or covers) ..... **$2,935**

**Option 01** — Internal Graticule ..... **NC**
**Option 09** — UL 544 Component Recognition ..... **NC**
**Option 10** — 25-pin Remote Program Connector X, Y, and Z, Single-ended Inputs ..... **+$55**
**Option 21** — Full Differential Inputs (X,Y,Z) ..... **+$60**
**Option 22** — Extended Gain Range 5X Attenuator ..... **+$45**
**Option 23** — Handle, Feet, and Covers (Not Available with Option 28) ..... **+$110**
**Option 24** — Linearized Z-Axis (Gamma Correction) ... **+$75**
**Option 25** — TTL Blanking ..... **+$75**
**Option 28** — Covers Only (Not Available with Option 23) ..... **+$90**
**Option 29** — Metal Bezel ..... **+$70**

#### OPTIONAL ACCESSORIES

**Rackmounting** — See page 86 for rackmounting accessories.

**Cameras** — A variety of cameras are available in a wide range of performance. See page 420 for camera recommendations.

## 606B Monitor

### Very High Resolution X-Y Display for Applications Requiring the Most Critically Sharp Photographs and Displays

The 606B offers image stability, gray-scale performance, and uniform brightness, critical to the quality of measurement or the accuracy of a medical diagnosis.

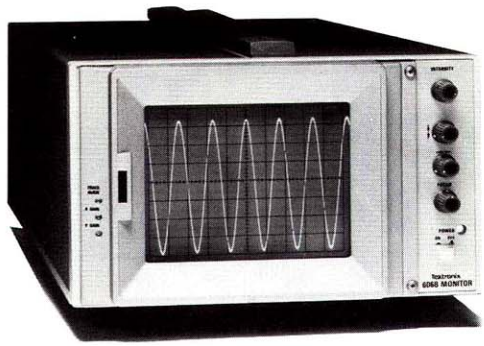
Uniform resolution and variable spot size are also provided by the 606B. The 606B's metal bezel is a solid mount for heavy cameras and prevents light leaks or distortion.

### CHARACTERISTICS

#### DISPLAY

**Type** — Flat-faced rectangular CRT.

**Dimensions** — 80 mm x 100 mm (3.2 in x 3.9 in).



**Display Linearity** — 1% of full scale along major axes.

**Spot Size** — 0.079 mm (3.1 mils) or less.

**Spot Growth** — Not >20% at constant intensity within the quality area (70 mm x 90 mm).

**Brightness Uniformity** — <10% variation within quality area (70 mm x 90 mm).

**Phosphor** — GH (P31) is standard.

#### VERTICAL AND HORIZONTAL AMPLIFIERS

**Risetime** — 116 ns or less.

**Settling Time** — <500 ns with deflection-input attenuation in 1X position.

**Bandwidth** — Dc to at least 3 MHz (−3 dB).
**Input** — Differential; BNC connectors.

**Deflection Factor (Vertical and Horizontal)** — Adjustable, 0.5 V to 2.5 V for 80 mm deflection.

**Input Impedance** — 1 MΩ or 50 Ω ±1%, paralleled by <47 pF; internally selectable.

**X-Y Phase Difference** — Not more than 1° to at least 500 kHz.

**Max Input Voltage** — 1 MΩ $Z_{in}$: ±100 V (dc peak ac). 50 Ω $Z_{in}$: ±5 V (dc peak ac).

#### Z-AXIS AMPLIFIER

**Input** — Differential; BNC connectors.

**Bandwidth** — Dc to 5 MHz (−3 dB).

**Risetime** — ≤35 ns.

**Sensitivity Range** — Adjustable from 0 V to 1 V to 0 V to 5 V for full intensity control.

#### AC POWER

**Voltage Ranges (±10%)** — 100 V ac, 110 V ac, 120 V ac, 200 V ac, 220 V ac, and 240 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Power** — 50 W nominal; 75 W maximum at 120 V ac.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 213 | 8.4 |
| Height | 133 | 5.2 |
| Depth | 519 | 20.4 |
| **Weight ≈** | **kg** | **lb** |
| Net | 7.9 | 17.5 |
| Shipping | 10.3 | 22.7 |

#### INCLUDED ACCESSORIES

25-pin connector (131-0570-00); 25-pin connector housing (200-0821-00); CRT graticule (337-1674-10); power cord (161-0123-00); service manual; operator's manual.

### ORDERING INFORMATION

**606B** Monitor (without handle, feet or covers) ..... **$4,780**

**Option 06** — UL 544 Listing (includes handle, feet, and covers) (shown above) ..... **+$125**
**Option 07** — Front-Panel Controls Changed to Screwdriver Adjustments ..... **+$30**
**Option 09** — UL 544 Component Recognized ..... **NC**
**Option 28** — With covers (not available with Option 06) **+$90**

#### OPTIONAL ACCESSORIES

**Rackmounting** — See page 86 for rackmounting accessories.

**Cameras** — A variety of cameras are available in a wide range of performance. See page 420 for camera recommendations.

**SPECIAL PRICING, TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFIED OEMS. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.**

620 (With Option 23)

## 620 Monitor

### General Purpose, Economical, X-Y Waveform Display

The 620 is a dependable, economical display, designed for electronic instrumentation, mechanical measurement instruments, and medical A-mode imaging applications.

**The 620 has Built-in Reliability**
With fewer parts and lower power consumption, display and system reliability are improved, and service costs are lower.

Option 20 allows DC operation from a single DC source (17-26 VDC, 1.0A), which further reduces power dissipation and weight.

All circuit boards and controls are conveniently located on one side for simplified interfacing, adjustments, and servicing.

**Package the 620 the Way You Want It**
A wide variety of packaging options are available for easy integration into your system.

Complete packaging descriptions follow the specifications below.

### CHARACTERISTICS

**DISPLAY**

**Type** — Flat-faced rectangular CRT.

**Dimensions** — 100 mm x 120 mm (3.9 in x 4.7 in).

**Phosphor** — GH (P31) is standard.

**Spot Size** — 0.38 mm (15 mils) at 0.5 μA.

**Linearity** — The voltage required to produce a 25-mm deflection from any point on the CRT will not vary more than 5%.

**Usable Brightness** — Up to 100 cd/m² (30 fL).

**VERTICAL AND HORIZONTAL AMPLIFIERS**

**Bandwidth** — Dc to 2 MHz.

**Settling Time** — 1 μs from any point on the CRT within 0.5 mm of final position.

**Deflection Factor** — (Adjustable) Vertical: ≤0.9 V to ≥1.5 V/100 mm. Horizontal: ≤0.8 V to ≥1.2 V/100 mm.

**Input R and C** — 1 MΩ paralled by <47 pF.

**X-Y Phase Difference** — 1° maximum, dc to 500 kHz.

**Max Input Voltage** — ±25 V (dc plus peak ac).

**Recommended Source Impedance** — ≤10 kΩ.

**Z-AXIS AMPLIFIER**

**Bandwidth** — Dc to ≥5 MHz.

**Input Sensitivity Range** — Not adjustable. 1.0 V will produce maximum brightness with Intensity Control set at mid-range.

**AC POWER**

**Voltage Ranges (±10%)** — 100 V ac, 110 V ac, 120 V ac, 200 V ac, 220 V ac and 240 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Power** — 26 W at 120 V ac (maximum).

**PHYSICAL CHARACTERISTICS**

| Dimensions | mm | in |
|---|---|---|
| Height (without feet) | 133 | 5.2 |
| Width | 213 | 8.4 |
| Depth | 500 | 19.7 |
| **Weight ≈** | **kg** | **lb** |
| Net | 5.3 | 11.7 |
| Shipping | 6.9 | 15.2 |

620 (With 016-0409-00)

**INCLUDED ACCESSORIES**

CRT graticule (331-0455-00); instruction manual; operator's manual.

### ORDERING INFORMATION

**620** Monitor
(without handle, feet or covers) ..... **$1,600**

**Option 01** — Internal Graticule (8 x 10 div at 12.2 mm/div) . **NC**
**Option 06*1** — UL 544 Listed (includes handle, feet, and covers) ..... **+$100**
**Option 09** — UL Component Recognition (not compatible with Option 06) ..... **NC**
**Option 10** — Remote 25-pin Program Connector, X, Y, Z-axes (not available with Option 31) ..... **+$55**
**Option 20** — Delete ac power. External dc Power Required (17 to 26 V, at 1.0 A), (not available with Option 06 or 31) **−$20**
**Option 23** — Handle, Feet and Covers, (not available with Options 06, 28, or 31) ..... **+$110**
**Option 25** — TTL Blanking ..... **+$50**
**Option 28** — With Covers Only — No Trim Strips (not available with Options 06, 23, or 31) ..... **+$90**
**Option 31** — Delete all Rear Panel BNCs, dc Power Connector and ac Power Supply and Switch. Provision for External dc Power (+17 V unregulated) is Provided. (not compatible with Options 06, 10, 20, 23 and 28). Can be Used with 016-0409-00 or 016-0410-00 Packaging ..... **−$25**

**1 Not available with Option 20, 23, 28, or 31.*

**SPECIAL PRICING, TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFIED OEMS. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.**

620 (With 016-0404-00)

**OPTIONAL ACCESSORIES (620)**

Modular Packaging allows you to combine the 620 Display with your own custom electronic circuitry in an adjacent compartment.

**Vertical Package** — Includes empty compartment, connecting hardware, handle, feet and covers. Order 016-0409-00 ..... **$345**

**Horizontal Package** — Includes empty compartment, connecting hardware, handle, feet and covers. Order 016-0410-00 ..... **$320**

**Rackmounting** — Includes empty compartment, frame, covers, and rack slides for mounting in a 19-inch rack. Not available with Options 06, 23, or 28. Order 016-0404-00 ..... **$415**

**Side-by-Side 620 Rackmounting** — To rackmount two 620s side by side in a 19-inch rack. Includes covers and rack slides. Not available with options 06, 23, 28, or 31. Order 016-0405-00 ..... **$295**

**Cameras** — A variety of cameras are available in a wide range of performance. See page 420 for camera recommendations.

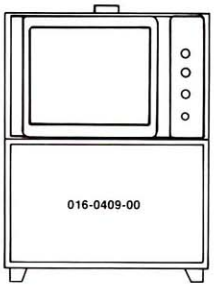
**RACKMOUNTING ACCESSORIES (606B, 608)**

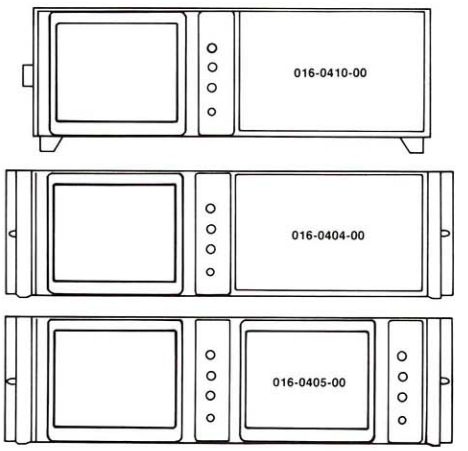
**Rackmount and Empty Cabinet Kit** — Slide-out 19 in rack assembly which mounts a display monitor and an empty compartment horizontally. In the compartment you may put your custom electronic circuitry and connect it to the display, all in one enclosure. Order 040-0601-00 ..... **$420**

**Display/Power Module Kit** — Allows rackmounting of a 606B or 608, with TM 503 Power Module. Minimizes mechanical design time. Simply design your own electronics using TM 500 Custom Plug-in kits described on page 401. Then plug them in. Fits standard 19 in rack. Order 040-0624-01 ..... **$120**

**Rackmounting Kit for 606B, 608,** — Slide-out 19 in rack assembly which rackmounts any two of the above displays side by side. Includes covers and rack sides. Order 040-0600-00 ..... **$250**

**Rackmount-to-Cabinet Conversion** — Required to convert a rackmount 606B or 608 to a cabinet style. Order 040-0602-00 ..... **$160**



## INTRODUCTION

Now you can rely on Tektronix as your single supply source for all media, pens and ink for your Tektronix copiers, plotters, printers and storage devices. By using Tektronix brand supplies, you can be assured of getting the best output quality of your Tek peripherals.

For further information, or to order any of the Tektronix brand supplies listed below, call your local Tektronix Sales Office.

## INK-JET SUPPLIES

**4691, 4692 Ink Cartridges**
200 ml Each

| | | |
|---|---|---|
| Cyan | 016-0713-00 | $85 |
| Black | 016-0714-00 | $85 |
| Yellow | 016-0715-00 | $85 |
| Magenta | 016-0716-00 | $85 |

**4691 Ink Jet Copy Paper**
500 Sheets Per Package

| | | |
|---|---|---|
| 216 x 279 mm (8.5 x 11 in) A Size | 016-0712-00 | $25 |
| 279 x 432 mm (11 x 17 in) B Size | 016-0711-00 | $40 |
| 297 x 210 mm (only for use with 4691 Option 01) A4 Size | 016-0709-00 | $20 |
| 297 x 420 mm (only for use with 4691 Option 01) A3 Size | 016-0710-00 | $35 |

**4692 Ink Jet Copy Paper**
500 Sheets Per Package

| | | |
|---|---|---|
| 216 x 279 mm (8.5 x 11 in) A Size | 016-0793-00 | $35 |
| 297 x 210 mm A4 Size | 016-0794-00 | $35 |

**4691 Transparency Film**
100 Sheets Per Package

| | | |
|---|---|---|
| A Size | 016-0765-00 | $85 |
| A4 Size | 016-0766-00 | $75 |

**4692 Transparency Film**
100 Sheets Per Package

| | | |
|---|---|---|
| A Size | 016-0765-02 | $90 |
| A4 Size | 016-0766-02 | $90 |

**4691 Drum Adaptors**

| | | |
|---|---|---|
| Package of 3 | 118-2593-00 | $15 |

**4692 Maintenance Cartridge**

| | | |
|---|---|---|
| 250 ml | 016-0777-00 | $10 |

**4695 Ink Cartridge Packages**
2.5 cc Each, 16 per package

| | | |
|---|---|---|
| Yellow | 016-0734-00 | $25 |
| Magenta | 016-0735-00 | $25 |
| Cyan | 016-0736-00 | $25 |
| Black | 016-0737-00 | $25 |

**4695 Ink Jet Copy Paper**
50 m Each 6 Rolls Per Box

| | | |
|---|---|---|
| Roll Paper | 016-0743-00 | $50 |

**4695 Ink Jet Copy Paper**
500 Sheets Per Package

| | | |
|---|---|---|
| A Size | 016-0739-00 | $25 |
| A4 Size | 016-0740-00 | $22 |

**4695 Transparency Film**

| | | |
|---|---|---|
| 100 Sheets Per Package | 016-0480-00 | $85 |

**Liquids**

| | | |
|---|---|---|
| Maintenance Liquid (200 cc) | 016-0732-00 | $10 |
| Print Head Protect Liquid (10 cc) | 016-0733-00 | $4.00 |

## PLOTTER PENS

**4663, 4662 Option 31**

| | | |
|---|---|---|
| Presentation Pack | 020-0888-00 | $60 |

**4663, 4662 Option 31 Paper Pens**
Regular Width
Individual Colors Available in 3-Pen Packs.

| | | |
|---|---|---|
| Black | 016-0414-00 | $8.00 |
| Brown | 016-0414-01 | $8.00 |
| Red | 016-0414-02 | $8.00 |
| Orange | 016-0414-03 | $8.00 |
| Yellow | 016-0414-04 | $8.00 |
| Green | 016-0414-05 | $8.00 |
| Blue | 016-0414-06 | $8.00 |
| Purple | 016-0414-07 | $8.00 |
| Magenta | 016-0414-08 | $8.00 |
| 9-Pen Multicolor Pack | 016-0414-09 | $25 |

**4663, 4662 Option 31 Paper Pens**
Fine Line
Individual Colors Available in 3-Pen Packs

| | | |
|---|---|---|
| Black | 016-0725-00 | $12 |
| Brown | 016-0725-01 | $12 |
| Red | 016-0725-02 | $12 |
| Orange | 016-0725-03 | $12 |
| Yellow | 016-0725-04 | $12 |
| Green | 016-0725-05 | $12 |
| Blue | 016-0725-06 | $12 |
| Purple | 016-0725-07 | $12 |
| Magenta | 016-0725-08 | $12 |
| 9-Pen Multicolor Pack | 016-0725-09 | $36 |

**4663, 4662 Option 31 Transparency Pens**
Individual Colors Available in 3-Pen Packs

| | | |
|---|---|---|
| Black | 016-0469-00 | $10 |
| Brown | 016-0469-01 | $10 |
| Red | 016-0469-02 | $10 |
| Orange | 016-0469-03 | $10 |
| Yellow | 016-0469-04 | $10 |
| Green | 016-0469-05 | $10 |
| Blue | 016-0469-06 | $10 |
| Purple | 016-0469-07 | $10 |
| Magenta | 016-0469-08 | $10 |
| 9-Pen Multicolor Pack | 016-0469-09 | $25 |

**4663, 4662 Option 31 Wet Ink Pens**

| | | |
|---|---|---|
| 0.3 mm (0.01 in) Dia Tip Pen Body | 016-0444-01 | $23 |
| 0.5 mm (0.02 in) Dia Tip Pen Body | 016-0442-01 | $23 |
| 0.8 mm (0.03 in) Dia Tip Pen Body | 016-0443-01 | $23 |

**Replacement Tips**

| | | |
|---|---|---|
| 0.3 mm (0.01 in) Dia Tip | 214-2706-00 | $16 |
| 0.5 mm (0.02 in) Dia Tip | 214-2706-01 | $16 |
| 0.8 mm (0.03 in) India Tip | 214-2706-02 | $16 |

**4662 Paper Pens Standard 1-Pen Unit**
Individual Colors Available in 3-Pen Packages

| | | |
|---|---|---|
| Red | 016-0589-00 | $8.00 |
| Green | 016-0589-01 | $8.00 |
| Black | 016-0589-02 | $8.00 |
| Blue | 016-0589-03 | $8.00 |

**4662 Transparency Pens (Standard 1-Pen Unit)**
Individual Colors are Available in 3-Pen Packages

| | | |
|---|---|---|
| Black | 016-0648-00 | $8.00 |
| Brown | 016-0648-01 | $8.00 |
| Red | 016-0648-02 | $8.00 |
| Orange | 016-0648-03 | $8.00 |
| Yellow | 016-0648-04 | $8.00 |
| Green | 016-0648-05 | $8.00 |
| Blue | 016-0648-06 | $8.00 |
| Purple | 016-0648-07 | $8.00 |
| Magneta | 016-0648-08 | $8.00 |

**4662 Wet Ink Pens (Standard 1-Pen Unit)**

| | | |
|---|---|---|
| 0.35 mm (0.014 in) Dia Tip Pen Body | 016-0448-00 | $24 |
| 0.46 mm (0.018 in) Dia Tip Pen Body | 016-0449-00 | $24 |
| 0.56 mm (0.022 in) Dia Tip Pen Body | 016-0450-00 | $24 |

**Replacement Tips**

| | | |
|---|---|---|
| 0.35 mm (0.014 in) Dia Tip | 016-0445-00 | $18 |
| 0.46 mm (0.018 in) Dia Tip | 016-0446-00 | $18 |
| 0.56 mm (0.022 in) Dia Tip | 016-0447-00 | $17 |

**Wet Ink Pen Accessories**

| | | |
|---|---|---|
| Replaceable Wet Ink Pens Parts Kit | 006-2968-01 | $18.25 |
| Extra Ink Single Cartridge | 016-0649-00 | $2.00 |
| Inks for Polyester Film (3/4 oz Squeeze Bottle) | | |
| Brown | 016-0423-00 | $3.00 |
| Green | 016-0424-00 | $3.00 |
| Blue | 016-0425-00 | $3.50 |
| Red | 016-0426-00 | $3.50 |
| Black | 016-0427-00 | $3.00 |
| Inks for Paper (3/4 oz Squeeze Bottle) | | |
| Black | 016-0428-00 | $5.00 |

**Wet Ink Cleaning and Maintenance Systems**

| | | |
|---|---|---|
| Ultrasonic Cleaning Tank | 002-1555-00 | $180 |
| Cleaning Fluid with Strainer 5.2 oz | 002-0920-01 | $5.00 |
| Pressure/Suction Cleaning Bulb | 002-1560-00 | $12 |
| Magnifying Instrument | 002-1558-00 | $95 |
| Pen Storage Humidifier | 002-1559-00 | $11.50 |

## PLOTTING MEDIA

**4662 Plotter Paper**
Blank White Paper

| | | |
|---|---|---|
| 280 x 432 mm (11 x 17 in) 100 Each B-Size | 006-2410-00 | $10 |
| Printed Paper | | |
| 10 x 10 cm (11 x 16.5 in) Grid 100 Each Linear Paper | 006-1698-00 | $12 |
| 10 x 10 cm (11 x 16.5 in) 100 Each Linear Paper | 006-1699-00 | $12 |
| 10 x 3 Cycle (11 x 16.5 in) 100 Each Semi-log Paper | 006-1700-00 | $12 |
| 10 x 2 Cycle (11 x 16.5 in) 100 Each Semi-log Paper | 006-1701-00 | $12 |
| 2 x 3 Cycle (11 x 16.5 in) 100 Each Full-log Paper | 006-1702-00 | $12 |

**Blank Paper**

| | | |
|---|---|---|
| Cream Colored, Punched 279 x 419 mm (11 x 16.5 in) | 006-6591-00 | $10 |

**4662 A-Size Plotter Film**
Quick Dry Plotter Film

| | | |
|---|---|---|
| 8.5 x 11 in 50 Sheet Package | 006-5939-00 | $30 |

**4663 C-Size Polyester Film**
Antistatic Polyester Film

| | | |
|---|---|---|
| 17 x 22 in, 100 Sheets | 006-2835-00 | $120 |

**4663 C-Size Plotting Paper**
Translucent Bond
18 in x 200 ft (2 Each) C-Size After Tear Off

| | | |
|---|---|---|
| Blank Roll Paper | 006-2837-00 | $40 |
| Translucent Bond 18 in x 200 ft (2 Each) Metric Size A2 After Tear Off Blank Roll Paper | 006-3473-00 | $42 |
| Translucent Bond 432 x 559 mm (17 x 22 in), 100 Each Blank Sheet | 006-3150-00 | $15 |
| Vellum, 100% Rag Content 432 x 559 mm (17 x 22 in) 100 Each Blank Sheet | 006-2836-00 | $45 |

## COPIER PAPER

**4631, 4632 and 4635**
**Tektronix Standard Dry Silver Paper**
216 mm x 152 m (8.5 in x 500 ft)

| | | |
|---|---|---|
| Single Roll | 006-1603-00 | $90 |
| 4 Roll Carton | 006-1603-01 | $320 |

**4633A, 4634 and 4635**
**Tektronix High Performance Dry Silver Paper**
216 mm x 152 m (8.5 in x 500 ft)

| | | |
|---|---|---|
| Single Roll | 006-2432-00 | $215 |
| 4 Roll Carton | 006-2432-01 | $750 |

**4611/4612 Dielectric Hard Copy Paper**
216 mm x 152 m (8.5 in x 500 ft)

| | | |
|---|---|---|
| 2 Roll Package | 006-2838-00 | $35 |

**4611/4612 Tektronix Dry Copy Toner**

| | | |
|---|---|---|
| 4.9 oz Bottle | 006-2990-00 | $23 |

## PRINTER PAPER AND RIBBONS

**4641 Printer Ribbon**

| | | |
|---|---|---|
| Box of 12 | 119-0820-00 | $180 |

**4642 Printer**
Paper-Tab Stock, Fan Fold, 270 mm x 279 mm, (10.6 x 11 in)

| | | |
|---|---|---|
| 2500 Sheets/Carton | 002-0262-01 | $65 |
| Paper Roll Box of 12 | 002-1084-01 | $70 |
| Ribbons Package of 4 | 002-1451-01 | $70 |

**4643 Printer Ribbon**

| | | |
|---|---|---|
| Cassette | 118-1314-00 | $25 |

## MAGNETIC MEDIA

**4110 Series 8 inch Flexible Magnetic disk**
512 kbytes Formatted Capacity

| | | |
|---|---|---|
| Box of 10 | 119-1376-01 | $110 |

**4170, 4925 and 4926 Option 25 Flexible 5 1/4 inch Disk**
650 kbytes Formatted Capacity

| | | |
|---|---|---|
| Box of 10 | 119-1583-01 | $55 |

**4905 Options 31 & 32 Flexible 8 inch Magnetic Disk**
315 kbytes Formatted Capacity

| | | |
|---|---|---|
| Package of 10 | 119-0848-01 | $115 |

**4907 Flexible 8 inch Magnetic Disk**
630 kbytes Formatted Capacity

| | | |
|---|---|---|
| Package of 10 | 119-1011-01 | $150 |

**4905 Options 33 and 34**
Hard Disk Pack Formatted Capacity

| | | |
|---|---|---|
| 5 Mbyte | 119-0855-00 | $250 |

**4909 Disk Cartridge**
13 Mbyte

| | | |
|---|---|---|
| Formatted Capacity | 119-1462-00 | $300 |

**4050 Series, 4923 and 4924**
Certified Data Cartridge

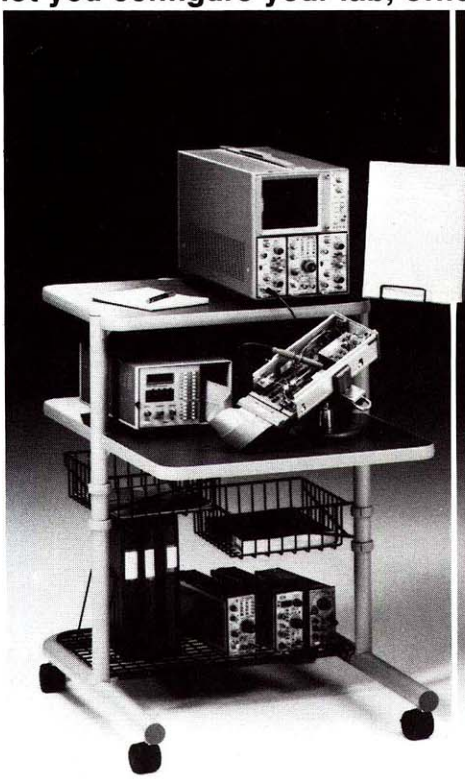
| | | |
|---|---|---|
| 300 ft Each Cartridge | 119-0680-00 | $30 |
| Package of 5 | 119-0680-01 | $120 |
| Certified Data Cartridge 450 ft Each Cartridge | 119-1439-00 | $35 |
| Certified Data Cartridge (4050 Series Only.) 600 ft Each Cartridge | 119-1463-00 | $45 |

NEW

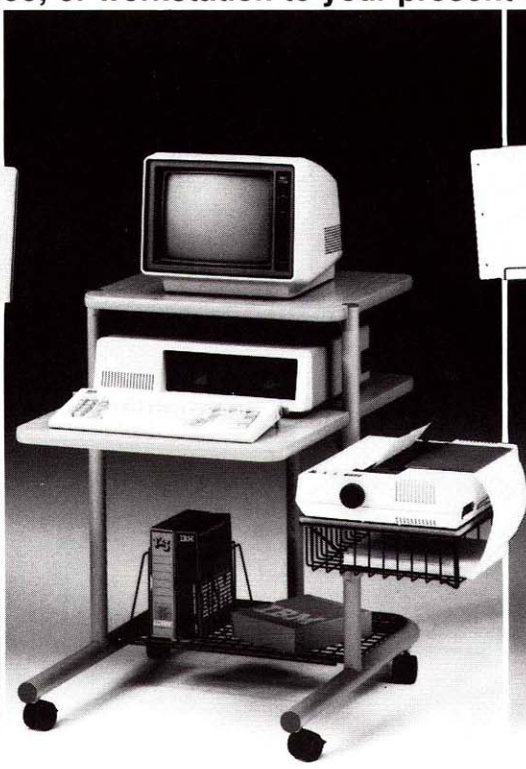
TERMINAL WORKSTATION

LAB/PC WORKSTATION

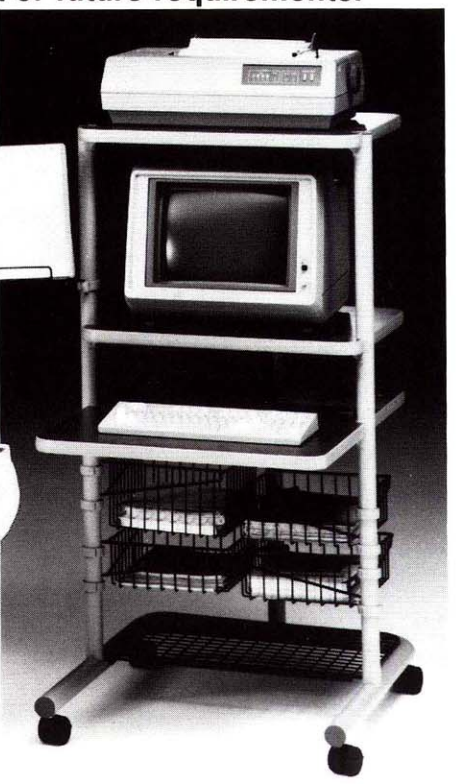
## Flexibility and versatility ..... let you configure your lab, office, or workstation to your present or future requirements.



*K324 Lab Workstation Configuration*



*K324 PC Workstation Configuration with Option 10 swing-out printer stand*



*K324 Terminal Workstation Configuration with extended shelf and additional baskets, Options 18, 14 and 15.*

**Ergonomically Designed and Configured for Individualized Fit**

**Modular Construction for Flexibility and Versatility**

**Sturdy, Steel Base Construction**

**Large Casters for Ease of Movement, Lock for Stability**

**Heavy-Duty Wire Storage Baskets**

This high-tech modular workstation line is designed for top efficiency and simplicity. Monitor and keyboard shelves are adjustable in 25 mm (one-inch) increments. Each workstation supports up to 68 kg (150 lb). Choose slate grey or light oak work surfaces, each complemented with a smoke tan metal finish. With the available options, these workstations have the flexibility needed to keep up with a changing office environment or workstyle.

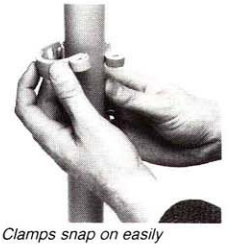
**PHYSICAL CHARACTERISTICS**

The following dimensions are the same for all models.

| Dimensions | mm | in |
|---|---|---|
| Width | 597 | 23.5 |
| Height | 889 | 35.0 |
| Height w/extended shelf | 1270 | 50.0 |
| Depth | 940 | 37.0 |
| **Weight** | **kg** | **lb** |
| Shipping*[1] | 34.1 | 75.0 |

*[1] Product shipped flat, easily assembled using supplied tools.*

**ANTHRO is a registered trademark of Anthro Corp., a wholly owned subsidiary of Tektronix, Inc.**



*Clamps snap on easily*

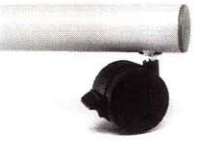
*Heavy duty wire baskets*

**RECOMMENDED WORKSTATION CONFIGURATIONS**

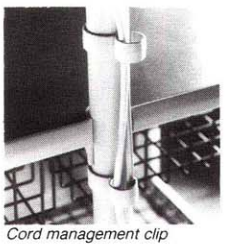
| Standard Features (Included with K324) | Lab | PC | Terminal |
|---|---|---|---|
| One Top Shelf (22 in x 21 in) and Document Stand | • | • | • |
| Keyboard Worksurface (23 3/4 in x 36 in) | • | • | • |
| Two Swing-Out 4 inch Baskets | • | • | • |
| Lower Platform Grille and Bookends | • | • | • |
| Cord Clips, Locking Casters | • | • | • |
| **Optional Features** | | | |
| One Swing-Out Printer Stand with Paper Basket (supports 80 column printer) | | Opt 10 | |
| One Extended Shelf with Brackets | | | Opt 18 |

**ORDERING INFORMATION**

**K324 Workstation** Light Oak Finish Work Surface ..... **$495**



*Durable, locking casters*



*Cord management clip*

**The following options allow you to configure your workstations in a number of ways to suit your individual application, or may be ordered later, as your needs change.*[1]**

**Option 01** — Slate Grey finish on all Worksurfaces ..... **NC**

**Option 10** — Swing-out Printer Stand with Paper Basket. Fits printers up to 419 mm (16.5 in) wide x 394 mm (15.5 in) long. Supports up to 44 kg (20 lb) ..... **+$100**

**Option 12** — Additional Shelf. Mounts above bottom grille. 560 mm (22 in) x 535 mm (21 in) size. Light Oak finish except when combined with Option 01 ..... **+$50**

**Option 14** — Additional Swing-out Basket. 102 mm (4 in) depth. Two included with each Workstation ..... **+$50**

**Option 15** — Additional Swing-out Basket. 152 mm (6 in) depth ..... **+$50**

**Option 18** — Extended Shelf Kit (recommend adding only one). Mounts above top shelf. 560 mm (22 in) x 535 mm (21 in) size. Light Oak finish except when combined with Option 01 ..... **+$125**

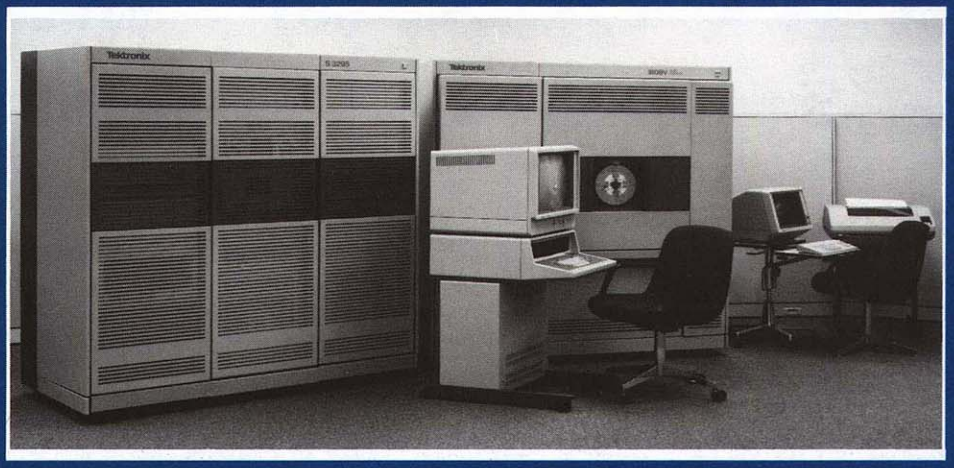
**Option 20** — Surge Protector. Provides protection from ac line spikes.*[1]

**Option 26** — Power Strip. Six outlets mount beneath work surface. One switch powers entire system.*[1]

*[1] Contact your nearest Tektronix office for further information.*

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

# DESIGN AUTOMATION PRODUCTS



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Design Automation Products provide support for the evolving requirements of the electronic designer. A full line of interrelated products are offered which are used to help design, verify, integrate, and test microcomputer and logic-based systems. These include the 318, 338, 1240, and DAS 9100 logic analyzers, the 8500 Series of microcomputer development systems, and the S-3295 VLSI Test System. Each Design Automation Product represents a Tektronix commitment to technical excellence, performance, and value.

# MICROCOMPUTER DEVELOPMENT PRODUCTS

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Tektronix Microcomputer Development Products Division offers the broadest range of quality multiple microprocessor support available today. Tektronix won't lock you into one microprocessor family or vendor. Plus, every Tektronix MDP System is backed with over 30 years experience in meeting designer's needs. We test our Development Products thoroughly to ensure performance and reliability. Each one provides complete development capability and the Tektronix commitment that guarantees you'll keep abreast of the fast paced microprocessor technology.

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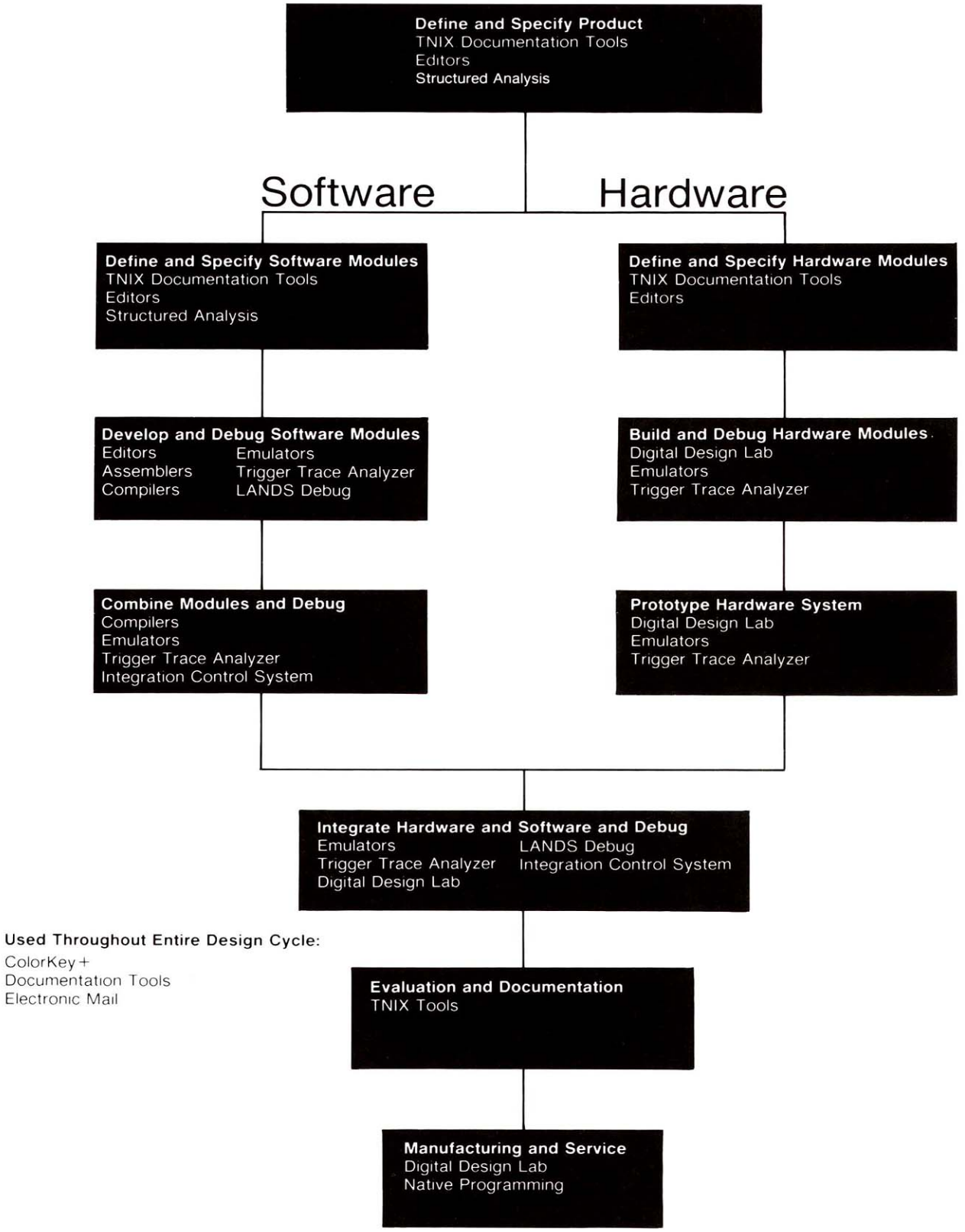
# Microcomputer Development Cycle



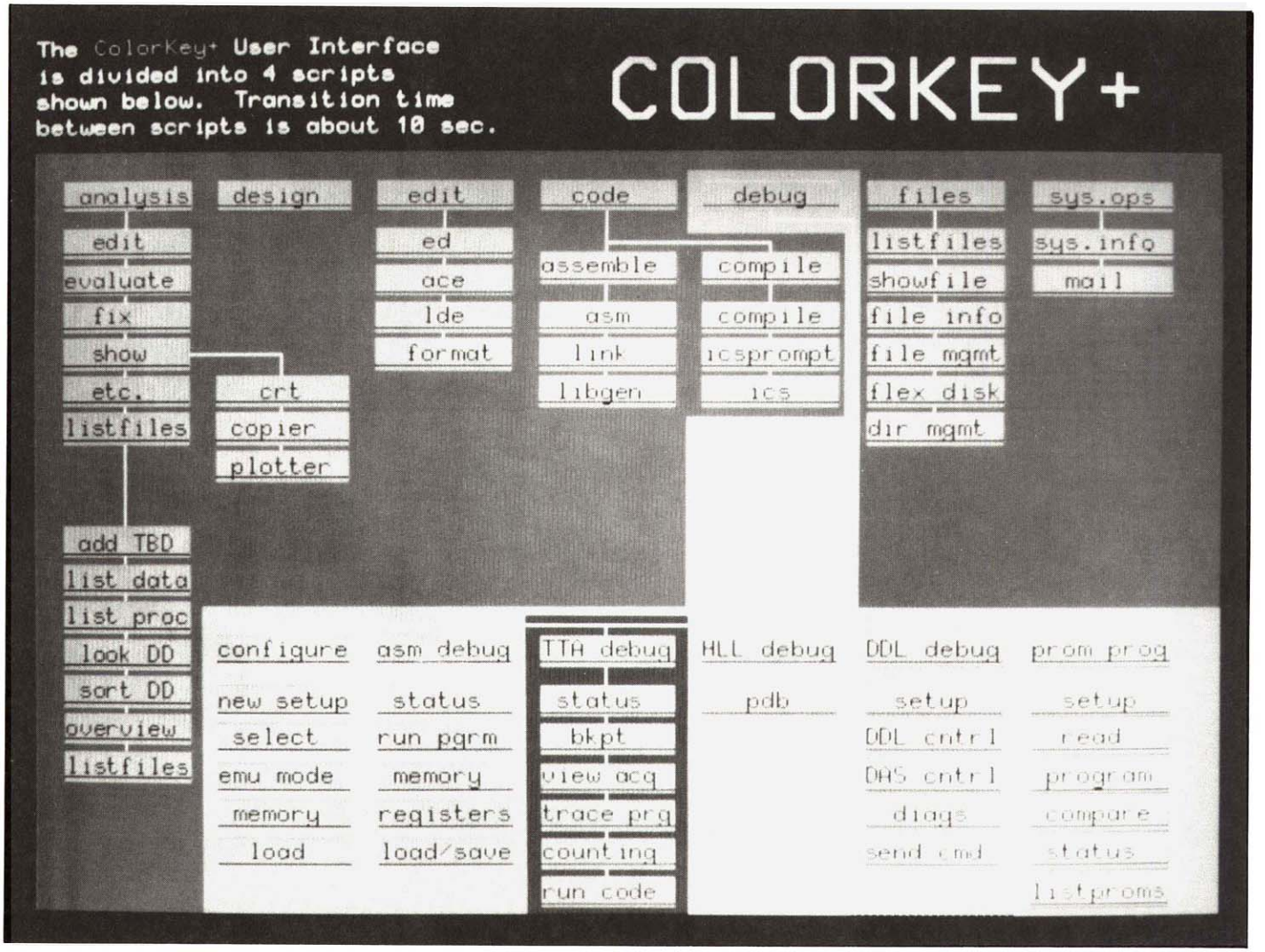
# Tek Tools Help You be More Productive Throughout the Entire Microcomputer Design Cycle

Over time, microcomputer designers have developed a systematic microcomputer design cycle which guides a microprocessor-based product from concept and definition through to manufacture and service. Each step in the cycle presents a unique set of problems and challenges to the engineer. Also, each step is critical to building a successful product.

Every phase in the cycle presents you with different demands. These demands are growing more complex as microcomputer hardware moves from the 8-bit to the 16-bit level and beyond. The only practical solution is more powerful design tools.

**Tek's 8500 Series Automates The Design Cycle.**
Only the Tektronix 8500 Series can give you design support broad enough to embrace the entire design cycle. No matter where you are in the cycle, Tektronix has design automation tools that dramatically increase the effectiveness of the engineer in developing a better product in less time and at a substantially lower cost.

Tek's 8500 Series design tools cover more design cycle tasks with greater effectiveness than any other engineering tool set on the market today. And they do so with a level of quality that has made Tektronix the leader in digital design instrumentation.



# Tek Microcomputer Development Systems Expand with Your Needs

No matter what the size and scope of your engineering operations, Tek provides a solid hardware and software foundation for your microcomputer design tool set.

## The 856X Family consists of the 8561, 8560, and the 8562

The 856X Series is designed to be 100% software compatible and hardware upgradable. Each member offers a specific combination of features with reasonable price/performance.

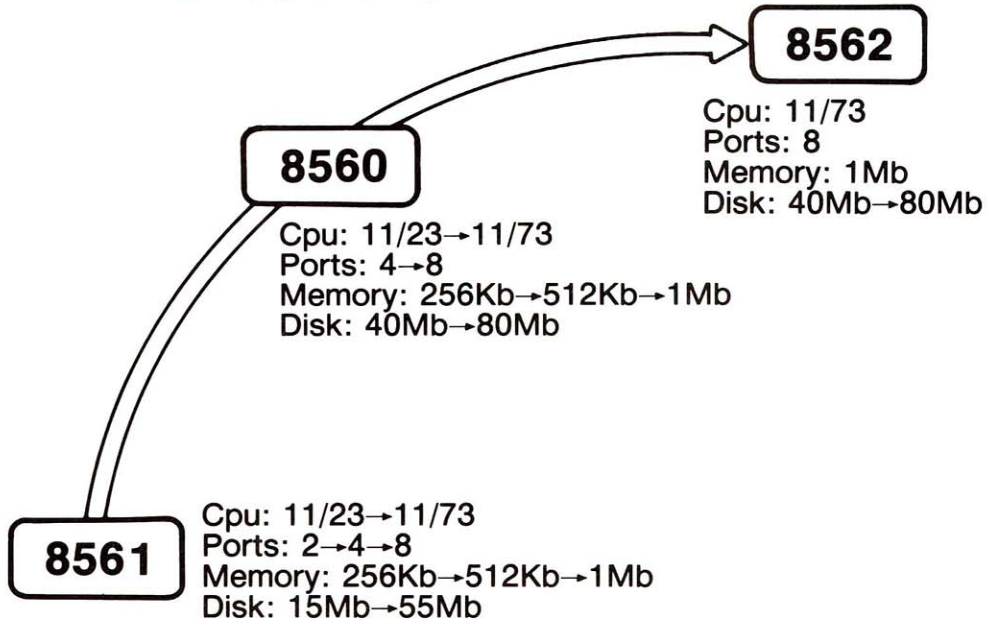
### 8561

The 8561 is a powerful, low cost entry-level software development system supporting one or two users. It provides a complete set of microcomputer design tools to the smaller design team while accommodating future expansion through a simple, cost-effective upgrade path.

The 8561 offers an LSI-11/23 CPU, a 15 Mbyte hard disk, a 1 Mbyte flexible disk, 256 kbyte of RAM memory, two user ports, and two line printer ports. This basic system can be easily upgraded within the same mainframe to an LSI-11/73 CPU, 55 Mbyte of hard disk, 512 kbyte or 1 Mbyte of RAM memory, a GPIB interface for disk backup, and four or eight user ports. All upgrades can be implemented through any Tektronix Service Center, and all Tektronix software development and integration tools remain fully functional after the upgrade.

Each 8561 user port can support either a standard CRT terminal, a Tektronix 4105 Color Terminal, or a Tektronix 8540 Integration Unit designed specifically to handle hardware/software integration tasks through realtime emulation.

## 856X Series Upgradibility




### 8560

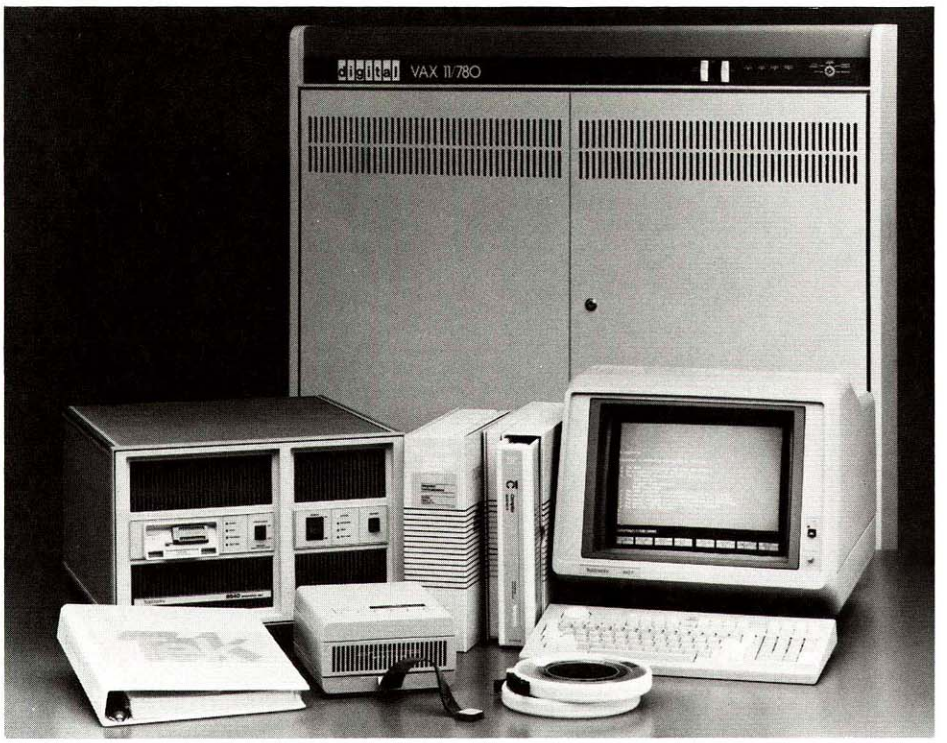
The 8560 offers a medium cost/performance software development system for four users. The same software design tools offered for the 8561 are available on the 8560 and the 8560 is also upgradable. A standard 8560 offers an LSI-11/23 CPU, a 40 Mbyte hard disk, a 1 Mbyte flexible disk, 256 kbyte of RAM memory, four user ports, and two line printer ports.

The 8560 can be easily upgraded within the same mainframe to an LSI-11/73 CPU, 80 Mbyte of hard disk, 512 k or 1 Mbyte of RAM memory, a GPIB interface for disk backup, and 8 user ports. Upgrades are handled similar to the 8561. The 8560's user ports, like the 8561, support standard CRT terminals, the 4105, and the 8540.

### *NEW* 8562

The 8562 is a high performance software development system which supports up to eight users. Compatible with the 8561 and 8560, the 8562 offers an LSI-11/73 CPU, 40 Mbyte hard disk, a 1 Mbyte flexible disk, 1 Mbyte of RAM memory, eight user ports, and two line printer ports. The 8562 can be upgraded with a GPIB interface for disk backup, or 80 Mbytes of disk storage within the same mainframe.

For large design teams, the 8562 offers a complete solution, at a very good price/performance ratio.




## TNIX Operating System

The TNIX Operating System present on all members of the 856X Series is derived from AT&T Bell Laboratories UNIX Operating System Version 7. TNIX is ideally suited to the team-oriented software design environment and contains many features targeted specifically at improving the productivity of individual engineers participating in a collective design effort.

### Multi-Tasking

TNIX increases user productivity by allowing several tasks to be performed simultaneously. For example, a source code file could be assembled or compiled while another is being edited. Or a file could be printed while the user views a document, etc.

### Hierarchical File System

TNIX provides a powerful hierarchical file system, where files can be arranged in a "tree" structure with many levels. Each level accommodates either files or file directories pointing to more files or directories at deeper levels. This file organization has several benefits. Files can be organized by project or function, which makes them easier to find and manipulate. Sublevel files can be easily protected by restricting access to top level directories. TNIX allows read, write and execute permissions to be assigned to files belonging to the owner, members of the group or all others.

User can also be assured of using the latest version of software by "sharing" (linking) to the master file. As the master file changes, all linked copies change also. Linked copies of the master file do not take up file space, another advantage.

### Electronic Mail

TNIX Electronic Mail provides a very easy way to transmit messages between individual users. Messages can be sent or received 24 hours a day, allowing users to communicate effectively. Mail can be sent between users on the same 856X or another 856X networked to it. Users are notified at login when mail has been sent to them.

When two or more users are actively using an 856X, they can send messages directly to each other's screen without leaving their desk. Also, the 856X system manager can "broadcast" a message to all active users at the same time to relay important information.

### Automated Software Creation

To simplify generation of large programs composed of many modules, TNIX features a tool called "make" which ensures that all interdependent source code modules have been reassembled or recompiled to reflect updates entered after debugging. Make minimizes recompilation by regenerating only those modules which have changed since the last build. It also eliminates build errors and provides a single, linked, executable object module with one command. Make also reduces support costs by documenting the build process, and can be used with assemblers, compilers and text processing tools.

## 8540 Integration Unit Support

The 856X Series is designed for easy interfacing to the Tektronix 8540 Integration Unit, which provides real-time emulation for the entire range of Tektronix 8-bit and 16-bit chip support. The entire 8540 command set is built into TNIX, allowing 8540 and 856X commands to be intermixed and invoked from a single workstation. Code developed on an 856X is downloaded to the 8540's program memory, up to 256 kbaud, for execution on the emulator processor. Transfers occur at 153.6 kbaud using the high speed interface between the 8540 and the 856X Series.

Code execution takes place under control of debug software, and the resulting data can be uploaded and analyzed using powerful data manipulation tools available in TNIX. This provides the H/W engineer with the UNIX productivity tools previously available only to S/W engineers.

## 856X Software Support for Microprocessor Design

The 856X Series supports a wide variety of software development and integration tools for over thirty of the most commonly used 8-bit and 16-bit microprocessors. Software available ranges from assemblers to high level support such as Pascal LANDS, the first Pascal microcomputer software development package that supports all phases of the design cycle.

At the source code entry stage, LANDS includes an easy to use Language-Directed Editor which understands Pascal syntax. As source code is entered, syntax errors are immediately identified so the user can easily correct them using the screen editing capability. LDE minimizes the edit/compile/edit cycle time associated with syntax errors, which are most common.

The LANDS Pascal compiler contains many enhancements aimed specifically at microcomputer programming. This includes features such as bit level data manipulation, assignment of variables to specific hardware addresses and direct access to I/O ports. Also, a separate optimizer pass can significantly reduce code volumes and boost performance.

LANDS also includes a unique tool for implementing the hardware/software interface, called the Integration Control System. The user simply responds to a menu or creates a brief file outlining parameters for the software/hardware interface. ICS automatically handles the details, such as creating linker command files, interrupt handling code, and reset/initialization code.
For hardware/software integration tasks, LANDS includes Pascal Debug, allowing all debug operations to be performed at the Pascal source code level. This completely eliminates the time-consuming requirements of translating assembly-level debug information into its high level counterpart.

### Tek/DEC Software Compatibility

Tek also offers powerful High Level Language tools and many popular assemblers on Digital Equipment Corporation's VAX Series of computers using either the VMS or UNIX based operating systems. This Tek/DEC combination gives you a powerful series of options when configuring your design environment. You can run Tek software development tools on the VAX to produce executable object code, and easily download the code to a Tek 8540 Integration Unit to perform emulation/debug tasks. Tek supplies you with the software needed to make your VAX/8540 combination function as a turn key system. In more advanced configurations, you can interface entire 8560/8540 systems to the VAX to create a powerful distributed processing system with the VAX acting as the central manager.

Regardless if you start with the entry level 8561 or a VAX 780, the Tek software tools will allow you to transport the programs you generate from one computer to another.

# Single Key Interactive Color Interface to Tek Design Tools

Colorkey+ and the Tek 4105 Color Computer Graphics terminal combine to give you simple, single key stroke access to the powerful TNIX operating system and Tek's microcomputer design tools.

The color coding and graphically defined "soft" keys guide you through the system with a minimum of effort or knowledge.

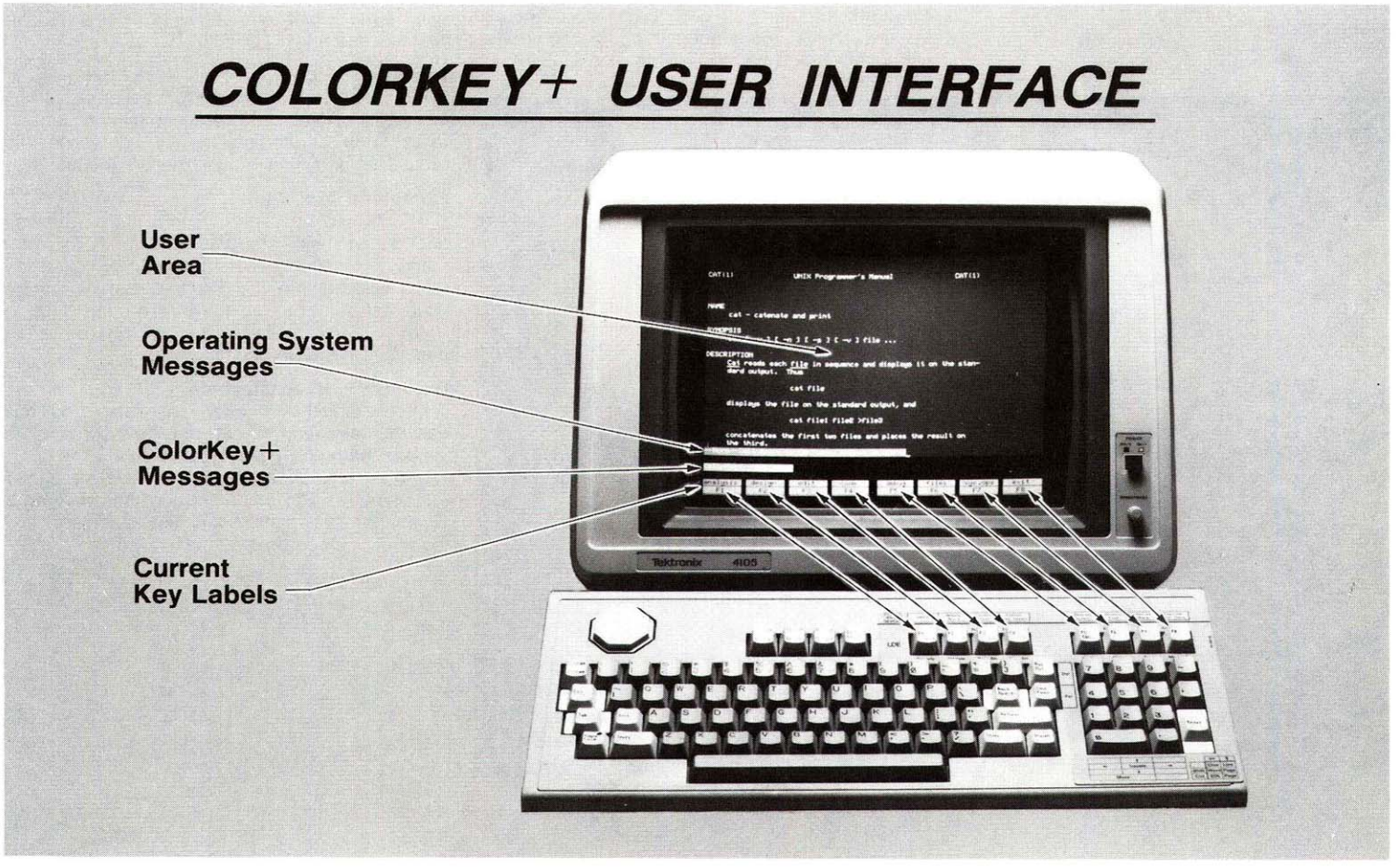
The use of color and softkeys minimize the time it takes new users to learn TNIX and use the emulation/debugging tools provided by the 8540 Integration Unit. Softkeys simplify command entry and minimize keystrokes. Softkey labels appear on the bottom of the screen and dynamically change as different operations are performed. Functions are arranged in a hierarchical manner, from major tools down to specific options for a selected command.

ColorKey+ is an intelligent interface. Parameters entered by the user are remembered and displayed as softkey options later whenever necessary. Previous commands can also be recalled, modified, and reissued. If a user requires more information about a softkey option, ColorKey+ will offer a longer explanation. And, if users "forget" where they are in the softkey command "tree" a "Where-AM-I" command graphically displays the command sequence and softkey levels.

Furthermore, as softkey commands are entered, ColorKey + displays the actual TNIX commands required to perform the operation. Eventually, the user learns most of the system commands and if desired, can directly issue commands to the system, bypassing ColorKey+.

Color is used by ColorKey+ to reduce user fatigue and to increase productivity. It maximizes readability of complex information. Different types of information being displayed can be highlighted using color. As an example, ColorKey+ uses red to display messages which require immediate attention, and brown for prompting the user.

**Colorkey+**
**User Interface**



NEW

MICROCOMPUTER DEVELOPMENT

# Tek Structured Analysis Tools Specify Conceptual Requirements Graphically

Tektronix Structured Analysis (SA) Tools, a set of graphically oriented, software development facilities, automate the method of specifying system requirements. Used in the first stage of a design cycle, they assure completeness and consistency in a specification.

SA methodology is based on a systematic, graphic, top-down technique of describing what a system does. Using SA, designers can develop an accurate and complete system specification before design begins.

The most important benefit of using SA methodology is an improved understanding of the system at an early stage in the project. This is largely due to SA's graphic notation which encourages feedback and thorough analysis. Without SA tools, manually maintaining the mechanical details of the methodology are tedious and error-prone.

SA Tools automate those functions that a computer can do best—editing the specifications and diagrams, detecting omissions in SA documents, maintaining consistency, and displaying the documents on screen and in hardcopy. While the computer handles the routine details, the designer is free to concentrate on system analysis. This results in improved product quality, reduced development time and costs, and effective project management.

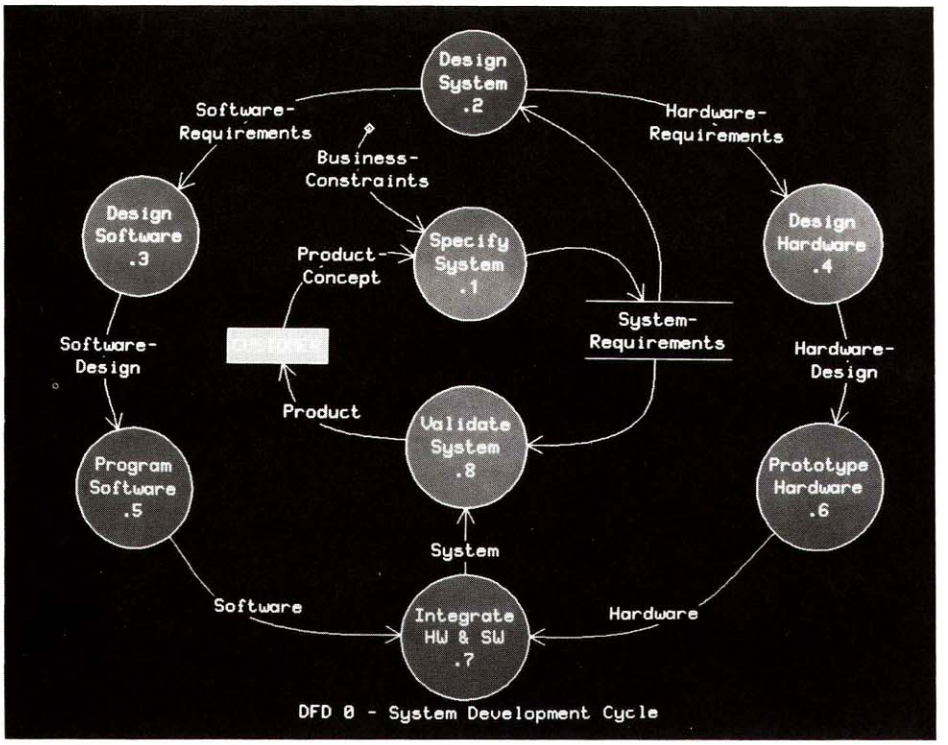
### SA Tools Functions

SA Tools support the SA methodology by automating the routine tasks of specifying a system. They let designers create, analyze, modify, and display a specification of the system to be developed.

| COMMAND | FUNCTION |
|---|---|
| **Main** | |
| editsa | Edits an SA document. |
| evalsa | Evaluates an SA document. |
| fixsa | Corrects an SA document. |
| showsa | Shows an SA document. |
| **Auxiliary** | |
| addtbd | Adds new entries to the DD. |
| dfdtoplot | Converts a DFD to the UNIX plot format. |
| listdf | Lists data flow names from SA documents. |
| listpnn | Lists process numbers and names from SA documents. |
| lookdd | Looks up an entry in the DD. |
| mono | Produces a monochrome copy of a DFD. |
| sortdd | Sorts DD entries alphabetically. |

### Editing

A special-purpose interactive graphics editor lets designers create and modify Data Flow Diagrams (DFD's) on-line. The editor commands can create, label, move, and delete each item on a DFD.



DFD 0 - System Development Cycle

### Evaluation

The evaluation function verifies consistency and completeness in the SA specification. The *evalsa* command analyzes the SA documents both individually and with respect to one another. It identifies inconsistencies and omissions in documents. It also evaluates a document for adherence to SA guidelines.

For example, the *evalsa* command checks consistency of data flows between a DFD and its parent, checks that the Data Dictionary (DD) defines all data used in DFD's and no other data, and checks DFD's for unconnected and read- or write-only data items.

### Correction

The correction function preserves consistency in the SA specifications as it is developed. The *fixsa* command automatically maintains consistency of process names and numbers in the specification. This command creates new documents with the proper name and number, and corrects documents with incorrect names and numbers. It also maintains consistency between DD entries and the data names in DFD's by adding or deleting DD entries to match new or changed DFD's.

### Display

The display function is used to show the SA specification on-line or to produce a hard copy. The *showsa* command displays formatted SA documents on the terminal.

Designers can also produce DFD hard copies quickly on Tektronix copiers and plotters. Copies can be full or half size, and in color or black and white.

### Auxiliary Functions

SA Tools provide additional functions for modifying the specification. These commands perform tasks such as sorting the DD or listing the processes and data used in the SA documents.

### Combined Tool Use.

SA Tools can be used in combination with one another and with standard TNIX or UNIX commands to perform more complex specification tasks. For example, the *listpnn* command can be used with the UNIX *sort* and *uniq* commands to produce an overview of the hierachy of DFD's and MS's in the SA specification.

### ColorKey+ User Interface

Tektronix ColorKey+ interface makes SA Tools easy to learn and use. Designers can access the various features by pressing function keys or by typing in commands directly. For example, a user can select an SA document and then perform a variety of tasks on that document without identifying the document for each task.

# Tek Editors Expedite Code and Text Entry

During software development and document preparation, high performance editors become critical tools in the design effort. Different tasks within the design cycle can be made more productive by using an editor specifically designed for the task. Also individual users have different preferences as to the type of editor they like to use. Tek offers a selection of editors to handle the different tasks and individual preferences.

**General Purpose Editors**
The TNIX line editor, "ed", lets you make sweeping changes in your code or documentation with a minimum of effort. With the streamlined command set of "ed", updates are easily accomplished.

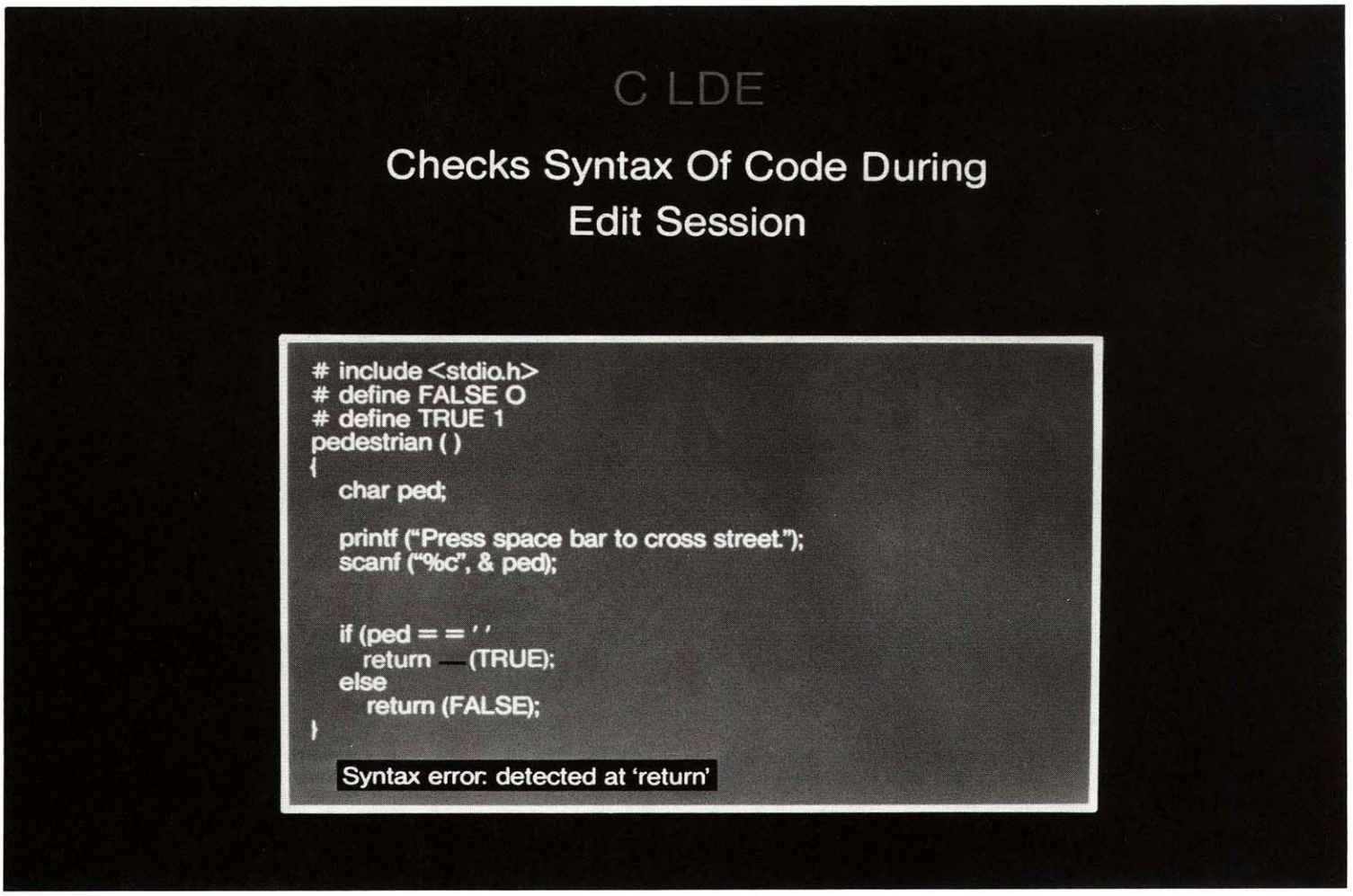
The Tek Advanced Screen-Oriented Editor (ACE) is an ideal choice for text entry and cursor-directed screen editing at specific locations within your code or text.

**High-Level Source Code Editors**
Tek's Language-Directed Editor (LDE) is an integral part of the Tek LANguage-oriented Development System (LANDS). LANDS allows editing, compiling, integrating, and debugging a program in the same high level for the entire cycle. The LANDS package consists of LDE for PASCAL or "C", Compiler, Integration Control System, and Debug, thus allowing the user to work through the S/W design and debug cycle while remaining at a high level.

LDE is actually able to understand the syntax of the Pascal or C language. Thus, it will flag any syntax errors in the source code you've entered while you are still in the editor. LDE's syntax error detection eliminates the need to run lengthy compilations just to locate syntax errors, LDE is also an excellent general purpose screen-oriented editor.

**Special Editing Tools**
The TNIX Auxiliary Utilities Package contains several specialized tools that allows sweeping changes to multiple files automatically. For example, if you have several assembler source files and you wish to change all the assembler directives, you could use these tools to accomplish this task automatically.

**Tek Gives You the Choice of Editor That Will Best Accomplish the Task You Wish to Perform.**



# Tek Compilers and Assemblers

Microcomputer software design demands a highly sophisticated set of programming tools that maintain high productivity while permitting logic manipulations all the way down to the hardware level. In response, Tek compilers and assemblers bring you an advanced feature set that streamlines your coding effort while retaining the power you need to implement machine-level operations.

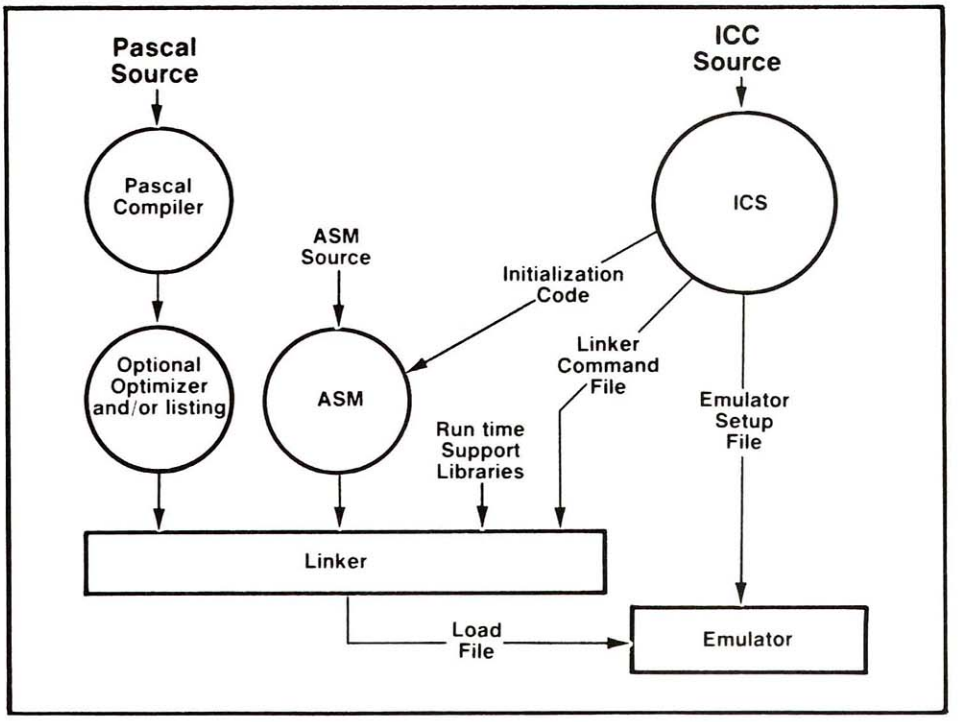
**High-Level Amenities for Assembly Coding**
With Tektronix assembler/linkers, you get many features that are normally only associated with high-level coding. You can create sophisticated macro statements that provide high-level coding power.

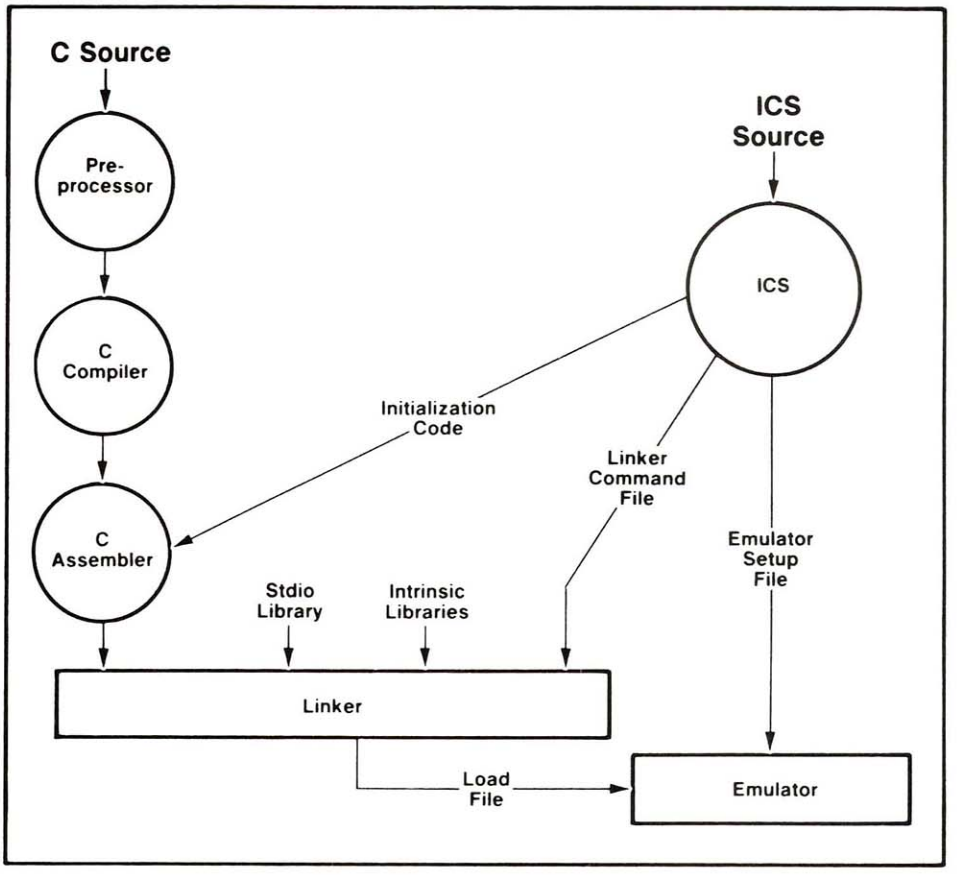
The INCLUDE directive can be used to include other files containing assembler source, data types, constants and variables. Conditionals, using Boolean expressions, are available to help you control the assembly process. In addition,

Tek assemblers all share the same base, which means once you learn a Tek assembler you can move from one microprocessor to another with a minimum of learning time. All the MACRO commands, expression handling and assembler directives are the same.

**Tek Compilers Offer More Than Generation of Quality Code**
For high-level language programming, Tek's PASCAL and "C" compilers give you all the established benefits of structured languages plus the ability to do operations such as interrupt handling, I/O port access and bit manipulation without ever having to resort to assembly language code.

To insure compatibility for porting existing programs, Tek's PASCAL-Compiler adheres to the ISO standard and Tek's "C" Compiler adheres to Kernighan and Ritchie's standard.



# LANDS Automates Hardware/Software Interface Definition with ICS

One major task associated with microcomputer design is to correctly interface the software with the specifics of the prototype hardware. When the software has been generated in a high-level language like PASCAL or "C", this task can become quite complex and time consuming. However, with Tek's Integration Control System (which is a standard part of Tek's compilers) the hardware/software interface definition is almost entirely automated.

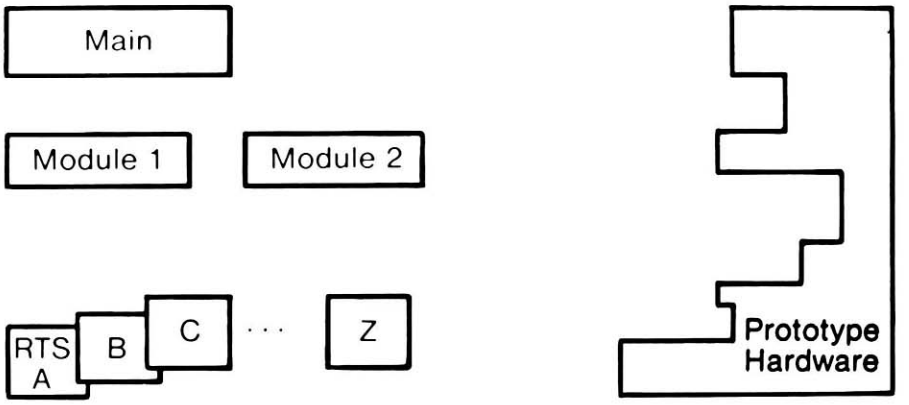
From a source file that specifies your hardware configuration, RAM and ROM locations, interrupts, etc., ICS generates the necessary code and command files to execute your code in your prototype.

**Linker Command File Automatically Generated**
ICS creates a linker command file which adheres to the memory parameters you've specified. Constants, instructions and global variables are all automatically assigned to their correct locations within the prototype address space.

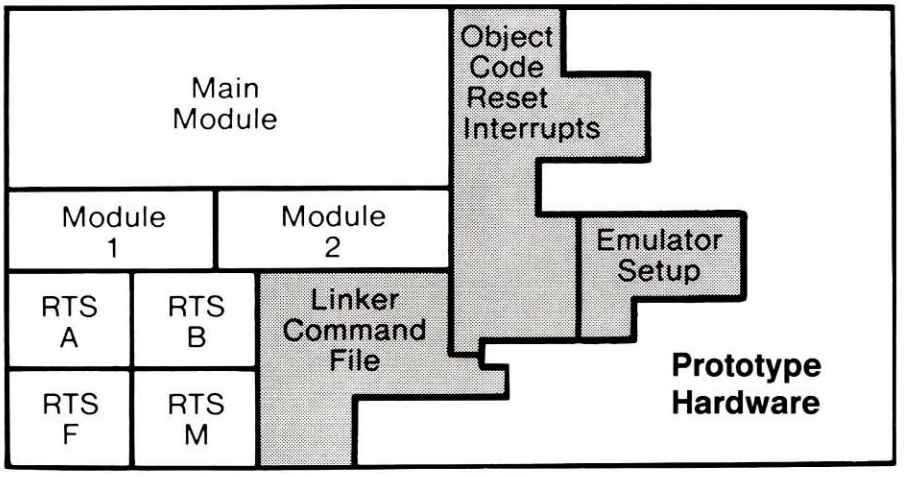
**Reset and Interrupt Handler Code Supplied**
ICS generates any code needed to link low-level interrupt vectors to your service routines. It also generates the object code needed to handle the initialization/reset operation. Normally, interrupt and initialization/reset code would have to be manually programmed in assembly language and then linked with the high-level code.

**ICS Creates Emulator Command File**
In addition to automating the hardware/software interface task, ICS also creates an emulator command file which allows you to download the linked object and execute it in a single command. You save both time and effort in the debug stage of the design cycle.

**The Integration Puzzle**




**ICS Brings it Together**



# LANDS High-Level Debug Pulls Debug Operations Up To The Source Code Level

With most development systems, any trace information accumulated by the debug software is displayed in an assembly code format. Unfortunately, this code bears little or no resemblance to the original PASCAL or "C" source code. A great deal of time and effort is spent figuring out the relationship between assembly-level debug information and the original source code.

Tek's LANguage-oriented Development System solves this long-standing problem through High-Level Debug, which translates debug information back into its counterparts at the PASCAL or "C" source code level.

### Track Real-Time Execution Bugs in Source Code

With High-Level Debug, all your debug commands can be entered using source code terminology. Breakpoints can be set on statement numbers, procedure/function names or on variables to halt program execution. Values can be returned to calling functions.

You can even single-step through your high level language program statement by statement or reset the program to its original starting point.

### Powerful Debug Display Features

High-level Debug also gives you the capability of displaying your program in high level source form, thus speeding the analysis. For instance, you can trace function calls and obtain a listing of each time the procedure is entered or exited and the value of any parameters. Also, variables can be displayed, modified and evaluated in their original source code terms. There is no need for the time-consuming task of translating hexadecimal responses to the corresponding high level language constructs.

```
# load "traffic.lo"
.....................................
# break wait
# go
Has walk button been pushed (y for yes, n for no)? y
Program breaks in wait at "mode2.c"#42
# source wait 9
"mode2.c"
   38:   wait(seconds)
   39:   int    seconds;              /*  amount of time to wait  */
   40:
   41:   {
   42:           intcounter = seconds;
   43:           /*  enable();  */
   44:           while (intcounter);
   45:           /*  disable();  */
   46:   }   /*  end wait  */
# seconds
3
# seconds = 5
5
# go
_
```

# Emulators and Trigger Trace Analyzer

Provide powerful insights into the interaction of software and hardware execution with emulators and trigger trace analyzer that reside in the 8540 integration unit.

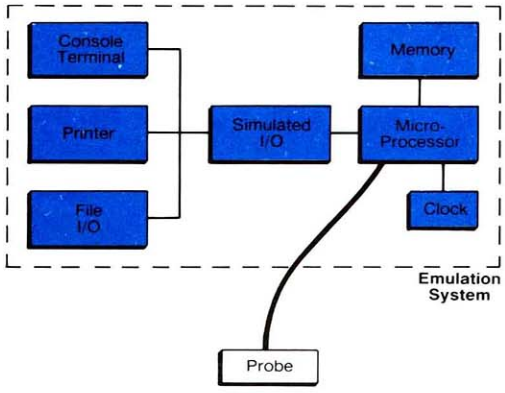
Emulation is well accepted as the most effective method of debug during hardware/software integration, and Tektronix is largely responsible for establishing it. Since 1977, when Tek introduced its 8080, 6800 and Z-80 emulators, the company has been the undisputed leader in supplying the microcomputer engineering community with superior emulation systems. In recent years, this leadership position has been enhanced by advances such as real-time emulation with no wait states and support for 16-bit processors, such as the Motorola 68000 Series and the Intel 8086/80186 Series.

**Real-Time Emulation**
Real-time emulation is accomplished by executing code on a processor identical in function to the one targeted for the prototype hardware. The emulator processor is run under the control of powerful debug software that allows control and tracing of the code's execution. This debug software does not need to be linked into your code or use any of your memory or interrupt lines.

Tek's superior emulators allow your code to execute in real-time, with no wait states inserted or clock pulses stretched. This means the emulator is fully transparent to the user; therefore you do not spend time "working around" the development system.

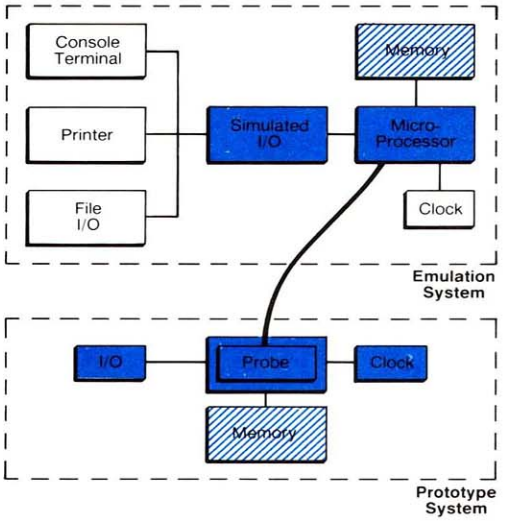
**Trigger Trace Analyzer Captures Real-Time Events**
A powerful option to Tek emulators is the Trigger Trace Analyzer, which uses a high-speed buffer to capture real-time software and hardware logic events, with the prototype running at the design's full specified operating speed. Multiple word recognizers allow you to define sophisticated triggers when tracing code execution. And data qualification allows you to capture only the data you wish to see.

**FULL FEATURE**
**Phased Emulation — Mode 0**



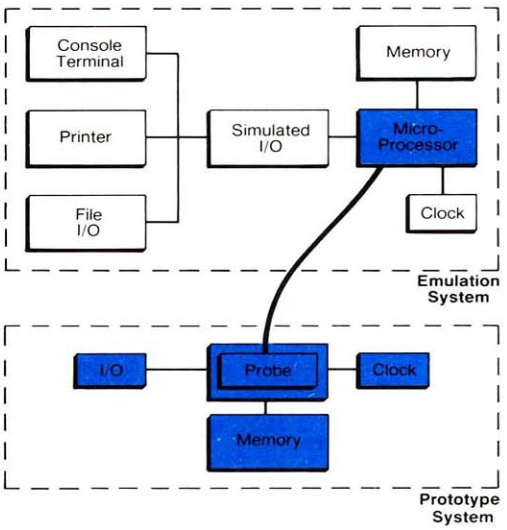

- Software Tested On Actual Microprocessor
- No Prototype Hardware Required
- Prototype I/O Interactions Are Simulated
- All Emulator Functions Are Available

**FULL FEATURE**
**Phased Emulation — Mode 1**




- Prototype Software & Hardware Tested Together
  - — All Clock, I/O & Interrupts Tested
  - — Real-Time Environment
- Memory Substitution
  - — No PROMs To Program
  - — Can Debug Without Working Memory System
- Program is Transferred To Prototype Memory In Steps
- All Emulator Functions Are Available

**FULL FEATURE**
**Phased Emulation — Mode 2**



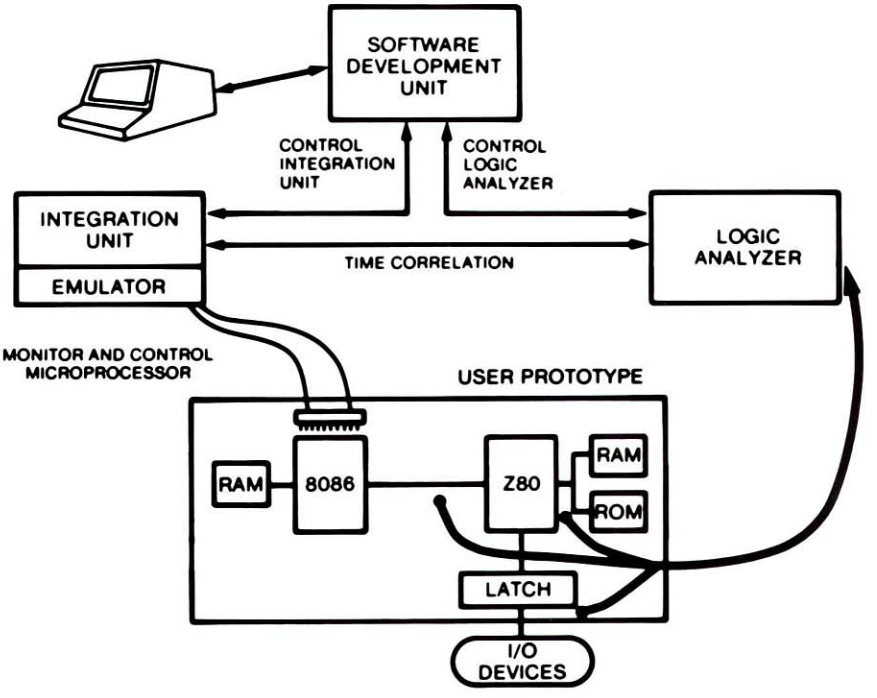

- Final Test Of Hardware & Software
- All Prototype Memory Tested
  - — PROM, ROM, Etc.
  - — Dynamic Or Static RAM
- All Emulator Features Available

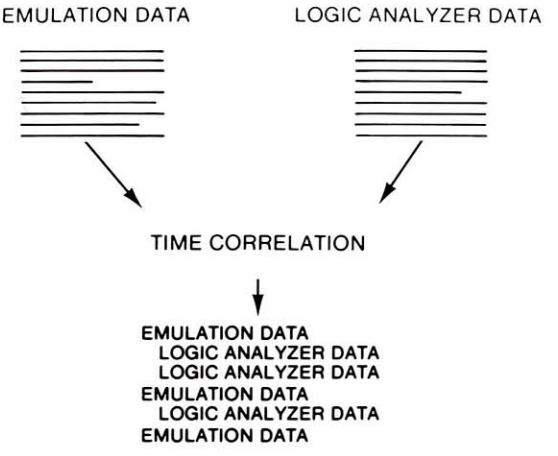
# Simultaneous Debugging of Multiple Processors

**Digital Design Lab (DDL)**
A greater number of microcomputer designs now involve either dual processors or a single processor closely coupled to other intelligent hardware within the prototype. Tek meets the challenge of these designs through the Digital Design Lab, which combines the power of the Tektronix 8560/8540 Microcomputer Development System with the Tektronix DAS 9100 Digital Analysis System.

Through a single terminal interface, the user has complete control of both systems. An 8540 Emulator traces one processor's execution while the DAS 9100 traces the second intelligent chip. The real-time data flow from these two sources is time stamped as it is stored in memory. The data can then be formatted in a time-synchronized manner for display and analysis. This time correlation capability allows you to see the cause and effect relationships between the two circuit elements being debugged. The result is a powerful insight into separate, but related data flows within the same prototype system.

## THE SOLUTION: TIME CORRELATION



These systems consist of assembler, emulator, probe and firmware, 8561 Multiuser Software Development Unit, 4105 Color Graphics terminal and 8540 Integration Unit with 64 kbytes of memory.

### ORDERING INFORMATION

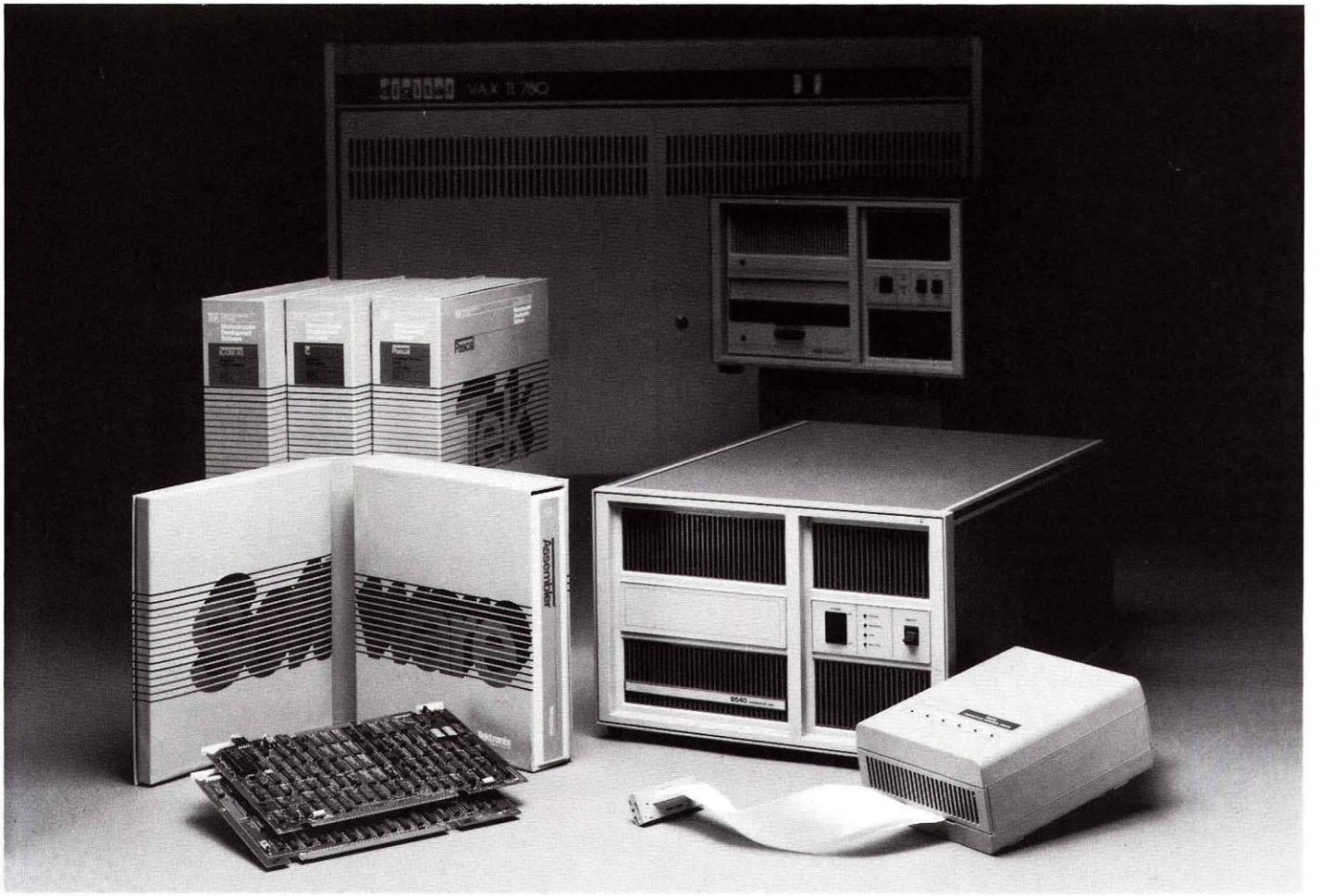
**856140A** Z80 Development System . **$29,700**
**856140B** 8085 Development System . **$29,700**
**856140C** 6800 Development System . **$29,700**
**856140E** 6809 Development System . **$29,700**
**856140F** NSC800 Development System ..... **$31,500**
**856140H** 7809/8/7 Development System ..... **$31,500**
**856140J** 7810/11/16 Development System ..... **$31,500**
**856140K** 78C05/06 Development System ..... **$31,500**
**Option 01** — Replace 8561 with 8560 ..... **+$11,000**
**Option 02** — 512 kbyte Memory for 856X ..... **+$2,000**
**Option 03** — 1 MEG Memory for 856X ..... **+$5,900**
**Option 06** — Trigger Trace Analyzer with F/W ..... **+$4,800**
**Option 10** — LSI 11/73 CPU with Floating Pt ..... **+$5,000**
***WARRANTY-PLUS* SERVICE PLANS—REFER TO PAGE 14**
**N1** — Service Plan + 9 Months Service for any of the above systems ..... **+$1,750**

## Microprocessor Development Systems

**8560** Multiuser Development System ..... **$24,500**
**8561** Multiuser Development System ..... **$13,500**
**Option 02** — Floating Point Option ..... **+$500**
**Option 03 (8560 Only)** — 5-8 Ports ..... **+$5,000**
**Option 04** — GPIB Interface ..... **+$2,500**
**Option 05** — 512 kbyte Memory ..... **+$2,000**
**Option 07** — 1 Mbyte Memory ..... **+$5,900**
**Option 08 (8561 Only)** — Four Total User Ports .... **+$2,500**
**Option 10** — LSI-11/73 CPU with Fltg Pt ..... **+$5,000**
**Option 47** — Rackmount Option ..... **+$125**
**8562** Multiuser Development System ..... **$36,000**
**Option 04** — GPIB Interface ..... **+$2,500**
**Option 09** — 80 Mbyte Total Disk Storage ..... **+$11,000**
***WARRANTY-PLUS* SERVICE PLANS—REFER TO PAGE 14**
**N1 (8560)** — Service Plan + 9 Months Service ..... **+$1,540**
**N1 (8561)** — Service Plan + 9 Months Service ..... **+$940**
**N1 (8562)** — Service Plan + 9 Months Service ..... **+$2,140**
**8540** Integration Unit ..... **$11,000**
**Option 01** — Communications Interface ..... **+$400**
**Option 03** — Trigger Trace Analyzer and Control F/W ..... **+$4,800**
**Option 04** — 64 kbyte Static Program Memory ..... **+$3,000**
**Option 05** — 128 kbyte Static Program Memory .... **+$5,600**
**Option 08** — TTA W/O Data Acq I/F and Probe ..... **+$3,800**
**Option 47** — Rackmount Kit ..... **$125**
***WARRANTY-PLUS* SERVICE PLANS—REFER TO PAGE 14**
**N1 (8540)** — Service Plan + 9 Months Service ..... **+$600**
**8540U04** Intel Interface Package ..... **$400**
**8550F06** Memory Allocation Controller ..... **$2,500**

### SOFTWARE

**ACEDIT** Ace Screen Editor ..... **$500**
**Option 1A** — Support for 8560/8561 ..... **NC**
**PLDEDIT** PASCAL Language Directed Editor ..... **$1,300**
**Option 1A** — Support for 8560/8561 ..... **NC**
**8560U01** Text Processing Package .... **$1,000**
**8560U02** Native Programming Package ..... **$1,000**
**8560U03** Auxiliary Utilities Package ..... **$500**
**These software packages require the Floating Point Option (Option 02 or 8560F02) in the 8560/8561.**
**8560U04** Intel Interface Package ..... **$500**
**8560U05** Unicom: Communications Package ..... **$1,000**
**DDL** Digital Design Lab Support ..... **$2,900**
**Option 1A** — 856X Support ..... **NC**
**Option 1B** — VAX UNIX TU-58 Cassette ..... **+$600**
**Option 1C** — VAX UNIX Reel Mag Tape ..... **+$600**



The V-Systems from Tektronix are systems designed to provide complete hardware and software support for design engineers needing the highest quality design tools available. The V-Systems are configured to integrate with an existing host computer, either an 856X Series or a VAX computer and include all the hardware and optionally the software required to do so. Included with the V-Systems are Tektronix's 8540 Integration unit, 64 kbytes of memory, 16-bit emulation support (emulator and probe), Integrated Logic Analysis, and as an option Tektronix's unique LANDS for high level language support. LANDS is available for either PASCAL or "C" and includes a Language Directed Editor, Compiler, Integration Control System, High Level Debugger, Assembler, Linker, and for supporting VAX computers, ICOM40.

### ORDERING INFORMATION

**V68000A** Emulation Support ..... **$24,900**
**V68008** Emulation Support ..... **$24,900**
**V68010** Emulation Support ..... **$24,900**
**Option 01** — 128 kbyte Memory ..... **+$3,000**
**Option 02** — MAC Board ..... **+$2,500**
**Option 03** — TTA 8-Bit External LA Probe ..... **+$1,000**
**Option 1A** — P-LANDS Support for 856X ..... **+$9,000**
**Option 1B** — P-LANDS VAX UNIX TU-58 Cassette ..... **+$12,000**
**Option 1C** — P-LANDS VAX UNIX Reel Mag Tape . **+$12,000**
**Option 1E** — P-LANDS VAX VMS TU-58 Cassette **+$12,000**
**Option 1F** — P-LANDS VAX VMS Reel Mag Tape . **+$12,000**
**Option 2B** — C-LANDS VAX UNIX TU-58 Cassette ..... **+$12,000**
**Option 2C** — C-LANDS VAX UNIX Reel Mag Tape **+$12,000**
**Option 2E** — C-LANDS VAX VMS TU-58 Cassette **+$12,000**
**Option 2F** — C-LANDS VAX VMS Reel Mag Tape . **+$12,000**
**V8086** Emulation Support ..... **$24,900**
**V8088** Emulation Support ..... **$24,900**
**Option 01** — 128 kbyte Memory ..... **+$3,000**
**Option 02** — MAC Board ..... **+$2,500**
**Option 03** — TTA 8-Bit External LA Probe ..... **+$1,000**
**V1750A** Emulation Support ..... **$33,500**
**Option 01** — 128 kbyte Memory ..... **+$3,000**
**Option 02** — MAC Board ..... **+$2,500**
**Option 03** — TTA 8-Bit External LA Probe ..... **+$1,000**
**Option 1A** — Assembler, 856X ..... **+$2,000**
**Option 1E** — Assembler, VAX VMS TU-58 Cassette **+$4,000**
**Option 1F** — Assembler, VAX VMS Reel Mag Tape . **+$4,000**
**Option 3A** — PIA W/Flying Leads, Clips ..... **+$750**
**Option 3B** — PIA W/Flying Leads, Pigtail ..... **+$650**
***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 14**
**N1 — Service Plan + 9 Months Service for any of the above V-Systems** ..... **+$990**
**VZ80** Emulation Support ..... **$17,900**
**V8085** Emulation Support ..... **$17,900**
**V6809** Emulation Support ..... **$17,900**
**VNSC800** Emulation Support ..... **$19,700**
**Option 03 — TTA Back Panel and Probe** ..... **+$1,000**
**Option 04 — Communications I/F for 8540** ..... **+$400**
**Option 1A — Assembler for 856X** ..... **+$1,700**
**Option 1B — Assembler for VAX UNIX TU-58 Tape** ..... **+$2,500**
**Option 1C — Assembler for VAX UNIX Reel Mag Tape** ..... **+$2,500**
**Option 1E — Assembler for VAX VMS TU-58 Tape** ..... **+$2,500**
**Option 1F — Assembler for VAX VMS Reel Mag Tape** ..... **+$2,500**
***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 14**
**N1 — Service Plan + 9 Months Service for any of the above V-Systems** ..... **+$820**

### INTERFACE SOFTWARE

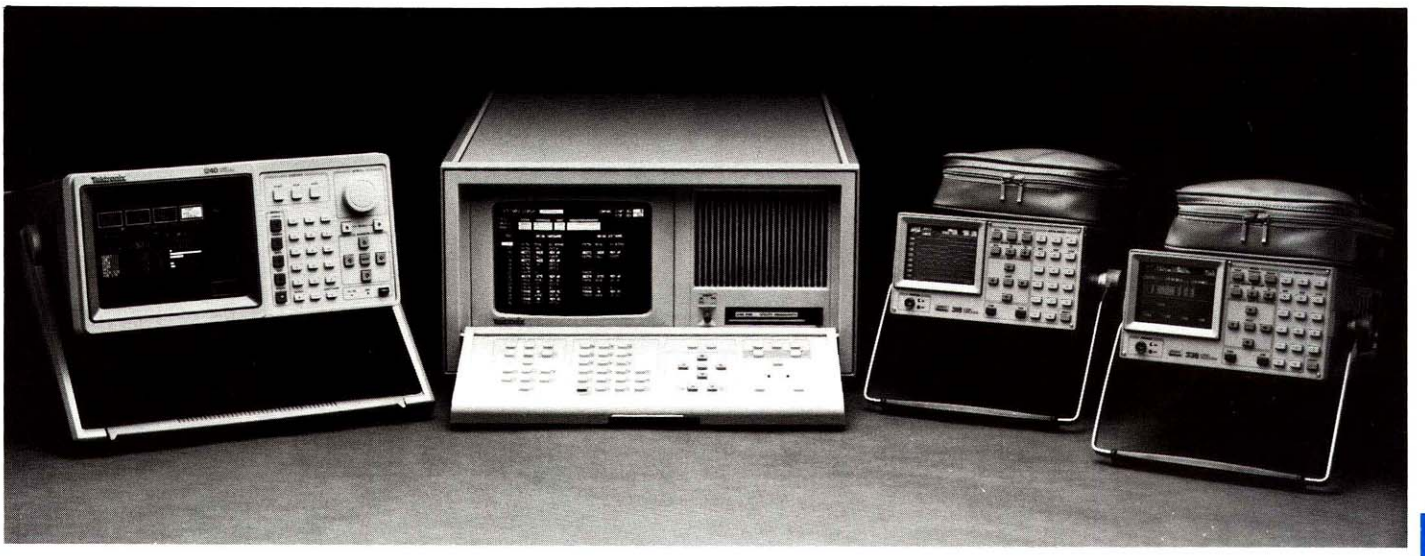
**ICOM40** Integrated Communications System for 8540 ..... **$2,000**
**Option 1B — VAX UNIX TU-58 Cassette Tape** ..... **NC**
**Option 1C — VAX UNIX Reel Mag Tape** ..... **NC**
**Option 1E — VAX VMS TU-58 Cassette Tape** ..... **NC**
**Option 1F — VAX VMS Reel Mag Tape** ..... **NC**
**Option 3B — VAX UNIX ICOM40 Source TU-58** .... **+$6,000**
**Option 3C — VAX UNIX ICOM40 Source Reel** ..... **+$6,000**
**COLORKY** ColorKey+ User Interface **$1,500**
**Option 1B — VAX UNIX TU-58 Cassette Tape** ..... **NC**
**Option 1C — VAX UNIX Reel Mag Tape** ..... **NC**
**Option 1E — VAX VMS TU-58 Cassette Tape** ..... **NC**
**Option 1F — VAX VMS Reel Mag Tape** ..... **NC**

### STRUCTURED ANALYSIS TOOLS

**STRUCTA** Structured Analysis Tools .. **$9,500**
**Option 1A — Support for 856X** ..... **NC**
**Option 1B — VAX UNIX TU-58 Cassette** ..... **+$5,000**
**Option 1C — VAX UNIX Reel Mag Tape** ..... **+$5,000**

**For information concerning other configurations, options, peripherals, available software, software subscription services, applications assistance, and customer training contact your local MDP Sales Engineer.**

# LOGIC ANALYZERS



*The Tektronix LA Family includes the 1240, the DAS 9100, the 318 and the 338 Logic Analyzers.*

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Tektronix offers a broad family of logic analyzers in four product lines:

**DAS 9100**
The Digital Analysis System 9100 Series offers three mainframes, six different data acquisition modules, pattern generation, tape cassette mass storage, systems interfaces, and microprocessor mnemonics. For high-speed applications, the DAS offers the fastest sample speed in the industry — 660 MHz, for timing resolution of 1.5 ns.

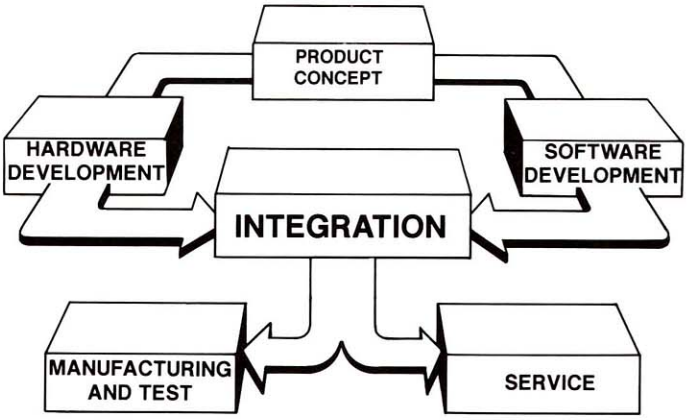
**1240**
Easily portable and rugged, the 1240 mainframe offers two types of data acquisition modules, microprocessor mnemonics, performance analysis, RAM/ROM pack mass storage, modular COMM pack system interfaces, and the industry's first true dual-timebase capability.

**300 Series**
When weight and size are of utmost importance, the 300 Series offers ultra-portability. Weighing only 11 lbs, the 308, 318, and 338 each offer state, timing, and serial analysis. The 308 also offers signature analysis. These three analyzers offer an unprecedented combination of performance, portability, and low price.

**7D01**
The 7D01 general purpose analyzer is a tried-and-true plug-in module for 7000 Series oscilloscope mainframes.

**Easy-to-Use**
All Tektronix logic analyzers are easy to use, because we believe the logic analyzer should allow you to concentrate on solving problems rather than learning to operate the analyzer. Clear screen displays, menu formatted operator interfaces, straightforward keyboard layouts, and simple, reliable mass storage media all contribute to the overall friendliness of the Tektronix logic analyzer family. Ease-of-use is further enhanced by such industry firsts as the color display in the DAS and the touch-screen soft keys in the 1240.

**Modular and Upgradable**
The DAS 9100 and 1240 modular mainframes allow you to customize your logic analyzer to meet your application needs. And if your needs change, you can easily upgrade your DAS or 1240 to keep pace with your new requirements.




Digital products follow a development cycle from initial concept, through hardware and software development and integration, to manufacturing and service. Each phase presents engineers with a different set of problems. To keep pace in the competitive world of digital design, you need tools that give you consistent support in all phases of the development cycle.

Tektronix offers logic analyzers with the flexibility and power to meet all your engineering needs. No matter where you are in the design cycle, Tektronix logic analyzers help you get the job done in less time, for less money, and with better results.

The following paragraphs describe logic analyzer features that help you in different phases of the product development cycle. The selection guide on the next page will help you select the analyzer that best meets your needs. For more information on a specific model, refer to the description on the following pages, or contact your Tektronix Sales Engineer.

**Clock Qualification**
A digital bus often carries irrelevant data as well as data of interest. Clock qualification lets you filter out irrelevant data by combining the acquisition clock with one or more bus signals. For example, you could use clock qualifiers to ensure that the analyzer stores only DMA transactions.

**Event Timing**
Timing relationships between signals are often critical. You might need to know how long a specific state lasts on one channel or on a bus. Or, you might need to know the elapsed time between two handshake signals. If you have an intermittent timing problem, you might want to trigger the analyzer only when timing parameters are exceeded.

**Glitch Triggering**
When debugging prototypes, you often encounter signal glitches. These glitches are usually symptoms of a circuit problem. To fully analyze the problem, you must be able to trigger on the glitch and isolate its occurrence.

**Pattern Generation**
The DAS 9100 is the first logic analyzer with both acquisition and pattern generation (stimulation) in the same instrument. Pattern generation makes it possible to start debugging hardware before the software, or all of the hardware, is available. You can also use it to test VLSI devices.

To exercise a circuit, you program the pattern generator to output data, clock, and strobe signals. These signals simulate bus activity or directly stimulate circuit elements in the prototype. The signals from these elements can then be acquired and analyzed.

In addition to hardware debugging, the tests created for the pattern generator can form the basis for evaluation, manufacturing, and service tests.

**Mnemonic Disassembly**
When debugging a microprocessor-based system, you need to see what the software is doing, and you need to see it in a familiar form. To simplify your job, the DAS 9100 and the 1240 feature a wide variety of single-plug probe connections and mnemonic disassembly software for popular processors and buses. Setup is easy: programmed tapes or ROM packs automatically customize the analyzer to support the specific processor.

For nonstandard processor designs, the DAS 9100 lets you design your own unique disassembly. This feature supports disassembly for custom or proprietary processors while maintaining complete confidentiality.

**Tracking Complex Program Flow**
In microprocessor-based systems, more than a simple sequential trigger is often required. You need the ability to track a complex sequence of software events through various jumps, loops, and branches. For example, you might be interested in monitoring subroutine X, but only when it is triple-nested under subroutines A and B. To do this, you need powerful and flexible word recognition that can track program flow through multiple decision points.

**Measuring Software Execution Time**
Efficient software performance depends, in large part, on minimizing the execution times of various routines. The DAS 9100 and the 1240 provide counter/timer functions that let you monitor the execution time of any portion of a program.

For example, in real-time operating systems, interrupt response time is critical. To check execution speed, you can start the timer when the interrupt signal is recognized and stop it when the last instruction in the routine is executed. This information lets you evaluate the performance of the routine and make necessary adjustments.

**Data Qualification**
Data qualification makes the most of available acquisition memory by selectively storing only the events you are interested in. For example, you might want to analyze a specific subroutine. To do this, you would store the events between the subroutine entry and exit points, but exclude all other events. Or, you might want to store a specific type of data (instruction fetches, for example), or activity at a critical address.

**Performance Analysis**
Performance analysis is an automated data collection, reduction, and processing technique available with the 1240. Performance analysis sorts and processes data on system activity, then displays statistical data in the form of histograms. For example, you can see statistical data on how often selected software modules are accessed, or on how long those modules take to execute. With this information, you can see where the processor is spending most of its time, and spot software bottlenecks and inefficiencies.

For another example, you can use performance analysis to monitor how the activity levels of certain routines change during interrupts. Or, you can evaluate software efficiency by monitoring the cycle types executed by the processor. You might find that your processor is executing many repetitive memory-to-memory operations that could be better handled by a DMA device.

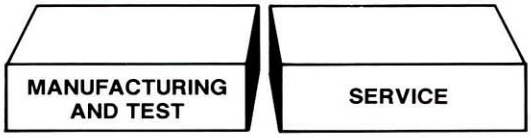
**Demultiplexing**
Both the DAS 9100 and the 1240 offer demultiplexing with single-probe connections for simple setup. In a demultiplexed display, different types of data are clearly separated and easy to follow.

For example, in order to verify read or write bus cycle timing in the 8086, you must use demultiplexing to separate the address, data, and bus cycle status signals.

**Dual Timebases**
The 1240 offers two independent, synchronous, time-aligned timebases. This feature lets you monitor the interaction of hardware and software, or track the interaction of multiple functional modules.

One example is a dual-processor system where the processors have different buses and run from unrelated clocks. A single timebase can be used to debug either of the modules separately, but you need dual synchronous timebases to monitor both processors and the interaction of the buses. The 1240 data display shows you a time-aligned picture of the data flow from both modules.

**Trigger Arming**
Both the DAS 9100 and the 1240 feature trigger arming. This technique lets you simultaneously acquire high-speed, asynchronous control signals and low-speed, synchronous bus signals. Data is displayed in a time-correlated fashion, with high-speed data displayed in correct reference to low-speed data. The advantage to this technique is that it allows you to use software flow to pinpoint problem areas in the control logic which might otherwise be difficult to locate.




**Pattern Generation**
Pattern generation combines with acquisition in the DAS 9100 to drive the test environment for your products or subassemblies. The DAS is also an effective tool for functional testing and verification of VLSI components.

**Remote Control**
Many testing applications call for your logic analyzer to interface with a larger computer system. Tektronix analyzers can be remotely operated over RS-232C or GPIB interfaces. This makes them ideally suited for automated test environments.

The DAS 91DVV VLSI Verification Software takes advantage of the DAS remote control capability by linking a DAS 9100 to a VAX host for benchtop VLSI testing.

**Mass Storage**
The DAS 9100 and the 1240 feature simple, rugged, mass storage media. You can store setups and memories for later use or for transport to another instrument. Storage is controlled from easy-to-use menus. You can easily name files to suit your needs, and save and restore them quickly.

Storing information makes it easy to transfer knowledge. Setups and memories created during engineering development can be easily passed to manufacturing for use in product testing. Service procedures developed at the factory can be easily duplicated and sent to the field.

**Master/Slave**
The DAS 9100 and the 1240 both provide master/slave support. This capability lets one analyzer communicate with another analyzer at a remote location over telephone lines. Major computer companies have established master/slave as an effective service technique. Maintenance personnel can use master/slave to solve complex problems at remote sites without ever having to leave the office.

**The 7A42 Logic Triggered Vertical Amplifier combines oscilloscope and logic analyzer functions. Refer to page 256 for more information.**

## SELECTION GUIDE

The right logic analyzer for you is the one that best meets the needs of your applications, present and future. To assist you in finding your optimum solution, the following selection guide compares some of the capabilities of the Tektronix logic analyzer family. For more information on a specific model, refer to the description on the following pages, or contact your Tektronix Sales Engineer.

| APPLICATION/FEATURE | DAS 9100 | 1240 | 318 | 338 | 308 | 7D01 |
|---|---|---|---|---|---|---|
| **Hardware Analysis** | | | | | | |
| Asynchronous acquisition rate, in MHz | 10, 25 100, 660 | 50, 100 | 50 | 20 | 20 | 100 |
| Trigger on simple program execution | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Measure event time/state count | ✓ | ✓ | | | | |
| Trigger on event time/state count | | ✓ | | | | |
| Clock qualification | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Simultaneous state/timing acquisition | ✓ | ✓ | | | | |
| Glitch capture | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Glitch triggering | ✓ | ✓ | ✓ | ✓ | | |
| Acquisition and reference memories | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Compare acquisition/reference memory | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Trigger input and output | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Pattern generation | ✓ | | | | | |
| **Software Analysis** | | | | | | |
| Synchronous acquisition rate, in MHz | 10, 25 100, 330 | 50 | 50 | 20 | 20 | 50 |
| Trigger on complex program flow | ✓ | ✓ | ✓ | ✓ | | |
| Measure execution time/state count | ✓ | ✓ | | | | |
| Trigger on execution time/state count | | ✓ | | | | |
| Data qualification | ✓ | ✓ | | | | |
| Microprocessor mnemonics | ✓ | ✓ | | | | |
| User-definable mnemonics | ✓ | | | | | |
| Performance Analysis | | ✓ | | | | |
| Analyze serial data to 9.6 kbaud | | | ✓ | ✓ | ✓ | |
| Analyze serial data to 19.2 kbaud | | | ✓ | ✓ | | |
| Analyze GPIB transactions | ✓ | ✓ | | | | ✓ |
| **Hardware/Software Integration** | | | | | | |
| Dual synchronous timebases | | ✓ | | | | |
| Trigger arming | ✓ | ✓ | | | | |
| Time-aligned state and timing displays | ✓ | ✓ | | | | |
| Demultiplexing | ✓ | ✓ | | | | |
| **Manufacturing and Test** | | | | | | |
| Controller interface | RS232 GPIB | RS232 GPIB | RS232 | RS232 | | |
| Pattern generation and acquisition | ✓ | | | | | |
| VLSI testing | ✓ | | | | | |
| Easily transportable storage media | Tape | Pack | | | | |
| Programmable via RS-232C | ✓ | ✓ | ✓ | ✓ | | |
| Programmable via GPIB | ✓ | ✓ | | | | |
| Video out for hard copy or monitor | ✓ | ✓ | ✓ | ✓ | | |
| Line printer output | ✓ | ✓ | | | | |
| **Service** | | | | | | |
| First line on-site | | ✓ | ✓ | ✓ | ✓ | |
| Permanent on-site | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Depot level | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Remote control via master/slave | ✓ | ✓ | | | | |
| Remote control via host controller | ✓ | ✓ | ✓ | ✓ | | |
| Signature analysis | | | | | ✓ | |

## GPIB IEEE-488 DAS 9100 SERIES

**Digital Analysis System**

The DAS 9100 Series Option 06 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**Color Display Enhances Ease-of-Use and Increases Productivity**

**Nine Standard Application Configurations Available or Custom Design Your Own System**

**Acquisition Speeds to 660 MHz (1.5 ns)**

**Data Widths to 104 Channels**

**Pattern Generation Up to 80 Channels at 25 MHz**

**Color, Monochrome and ATE Mainframes**

**Modular Architecture for the Future**

**DesignLink® Software Links DAS 9100 to a Host for Bench-Top VLSI Functional Testing**

**Disassembly Support for Over 30 Microprocessors and Buses**

**Memory Depths from 512 to 4096 Bits Per Channel**

**Patented EDM Disassembles Proprietary Processors and Buses**

**Select Triggering to 16 Levels**

**Patented Time Correlation of High- And Low-Speed Data**

**Separate Glitch Memory**

**State-Table and Timing Diagrams Displayed for all Channels**

**Pattern Generation to Simulate Hardware or Software**

**Delta Time and Auto-Run Mode**

**Supports GPIB, RS-232, Hard-Copy Units and Serial Line Printers**

**Tape Drive Stores Patterns and Instrument Set-Ups for Future Use**

### The Industry Standard

The DAS 9100 Series Digital Analysis System has set the industry standard for virtually all aspects of logic analysis. Its modular mainframe accepts a wide assortment of both data acquisition and pattern generation modules to fit your application needs. You get performance combinations unavailable in any other logic analyzer, including data widths to 104 channels and acquisition speeds up to 660 MHz. Another DAS 9100 innovation is the inclusion of pattern generation modules, up to 80 channels, which can be used in concert with data acquisition modules to perform sophisticated test procedures, such as VLSI Functional Test.

Also, the DAS is unmatched in its ability to adapt to almost any engineering work environment. It has the capacity to interface with mainframes, GPIB controllers, development systems and other DASs. For stand-alone situations, there's a built-in tape storage unit and the DAS outputs to both hard copy units and serial line printers.

### The Leader in Ease-of-Use

The DAS 9100 has an unmatched feature set that makes it the undisputed leader in ease-of-use. The Color DAS 9129 is currently the only logic analyzer available on the market with a color-coded CRT. Each of the instrument's setup menus and data displays are organized into color groups which promote faster interaction, better understanding, reduce chance of error and minimize fatigue.

The color coding scheme is the product of intensive research by Tektronix into the use of color to enhance user productivity during interaction with a CRT display. The CRT supports three colors, red, yellow and green, plus the black background. These color phosphors fall within a common focal depth, which means the eye does not have to refocus when scanning from one color to another.

See this color product in the reference section beginning on page 17.

Green (a "quiet" color), is used to display supporting information in an unobtrusive manner. Yellow (a more agressive color), is applied to information of immediate interest, such as acquired data. Red, which attracts immediate attention, is reserved for exceptional situations, such as marking the trigger point in a data stream or listing illegal instructions during a disassembly.

Both the Color DAS and its monochrome counterpart have a menu-driven operating system which vastly simplifies all user interactions. Each particular function, such as trigger setup or pattern generation programming, has its own menu which is largely self-explanatory. The user simply moves the cursor to the appropriate video fields and supplies the required information. There is no need for lengthy manual references to master the instrument's operation. When a menu entry falls outside acceptable bounds, a message appears which explains the specific nature of the error, thus allowing simple recovery without the need for a separate help function.

The operating system also includes features which promote fast accurate analysis of acquired data. A reference memory compare color-codes all differences between acquisition and reference memories. The Delta Time feature allows precise measurements of the time interval located between movable cursors.

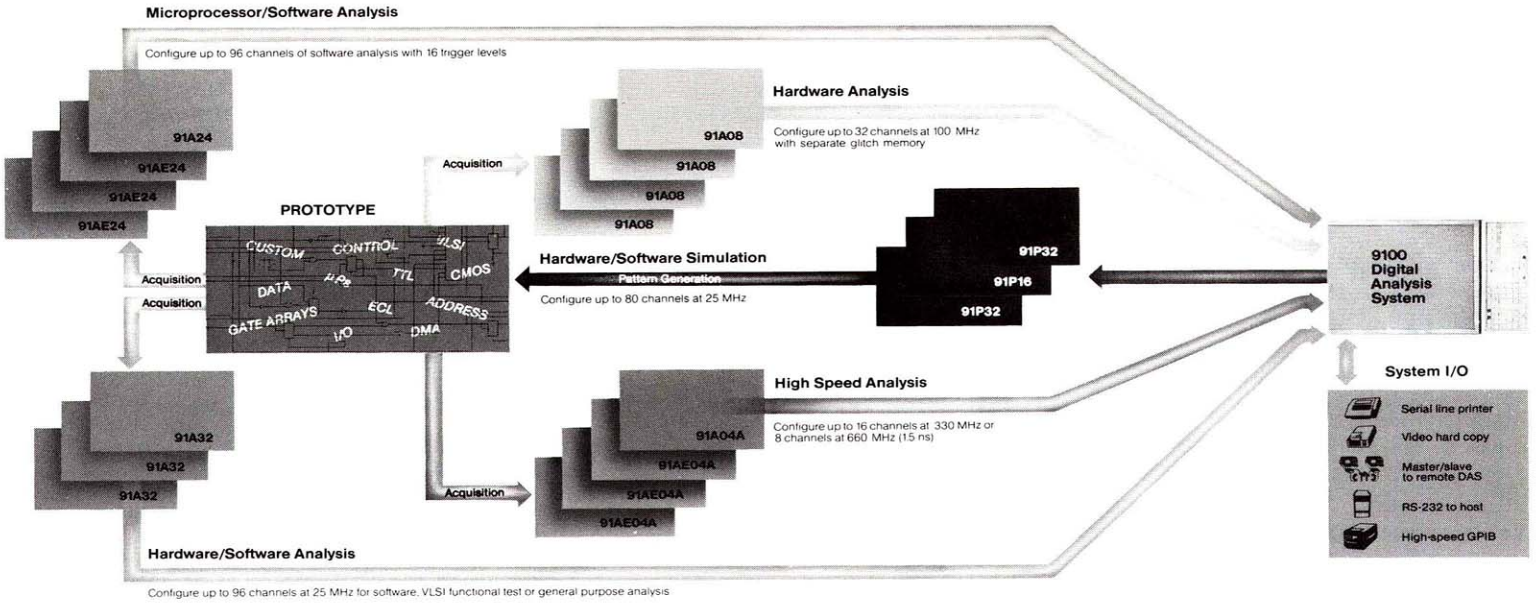
A major benefit in most engineering situations is the ability to retain instrument setups and reference data for future use. The DAS 9100 has a built-in DC 100 cartridge tape drive, which retains complete instrument setups as well as reference memory data and mnemonic definition tables used to disassemble acquired data. All tape drive I/O operations are accomplished through a simple, menu-driven filing system.

### 8-Bit and 16-Bit Microprocessor Design Support at its Best

In response to the overwhelming need for good microprocessor design support in logic analysis, the DAS 9100 Series offers a greater depth and range of microprocessor-based support than any other analyzer.

The key to this support is the DAS 9100's new Patented Extended Define Mnemonics, which allows the unit's built-in DC 100 tape drive to act as a storage medium for mnemonic tables for 8-bit, 16-bit and even custom processors.

EDM (Extended Define Mnemonics) is a powerful, table-driven program which is part of the DAS firmware. EDM performs disassembly of data acquired synchronously off a microcomputer system bus. EDM uses a series of nested tables to complete the disassembly. All address, data and control information is received by a master table and passed down through a hierarchy of tables which converts it into disassembled mnemonics. For custom processors, you can create your own set of tables. For commercial processors, Tek has a wide array of both 8-bit and 16-bit EDM tapes available, which will automatically complete the disassembly for you.



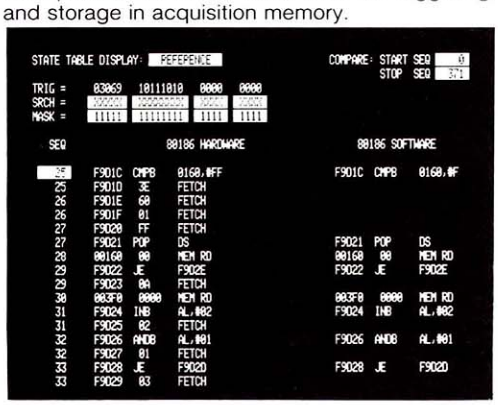

Select from one of the following support packages or use EDM to create a disassembly program for your own custom processor:

| | | | |
|---|---|---|---|
| 8080 | 6801 | 68010 | 1805 |
| 8031 | 6802 | Z80 | NSC800 |
| 8039 | 6803 | Z8001 | F9450 |
| 8085 | 6805 | Z8002 | 1750A |
| 8086 | 6808 | Z8003 | UNIBUS |
| 8088 | 6809 | Z8004 | Q-Bus |
| 80186 | 68121 | 6502 | GPIB |
| 80188 | 68000 | 65C02 | ASCII |
| 6800 | 68008 | 1802 | EBCDIC |

NOTE: For Ordering Information consult the microprocessor support section on pages 122 and 123.

Each 8-bit EDM disassembly tape includes a full set of disassembly tables and also a file containing all the setup parameters needed to have the 91A24 data acquisition modules acquire software transactions as executed on the system bus. For even further convenience, there is a Probe Interface Adaptor which allows all probe hookups to the processor to be completed in a single connection.

At the 16-bit level, EDM tapes are used in conjunction with the new PM 200 Series to complete the disassembly. Each PM 200 module probes the 16-bit processor under test and uses discrete logic to interpret data flow for disassembly, including operations such as clock synthesis and monitoring the fetch queue. The acquired data is then passed on to the DAS itself for triggering and storage in acquisition memory.




*A State Table Display illustrating 80186 EDM Disassembly in hardware and software format.*

Only the DAS 9100 allows you to select the disassembly format you need: Software, hardware or absolute.

At both the 8-bit and 16-bit level, EDM has a powerful and flexible feature set which makes the DAS 9100 the leader in software analysis support. EDM gives you three distinct types of disassembly: Software disassembly, which presents software flow in a similar format to an assembly listing; hardware disassembly, which shows mnemonics along with all processor cycles; and absolute disassembly, which identifies each bus cycle by type and gives the hexidecimal values associated with each cycle. EDM also allows user selectable color coding of displayed data and the addition of comments and labels. You can even use disassembly mnemonics when defining triggers with the 91A24 trigger menu.

## SELECT YOUR CONFIGURATION

The DAS 9100 has six different data acquisition modules. Each has its own data width and maximum speed: 24 channels at 10 MHz for software analysis (96 channels maximum); 32 channels at 25 MHz (96 channels maximum); 8 channels at 100 MHz with glitch memory (32 channels maximum); 4 channels at 330 MHz (16 channels maximum) or two channels at 660 MHz (8 channels maximum). Modules can be combined to give you the logic analyzer you need.

Need high speed performance? One module can track your system clock (synchronously) at speeds to 330 MHz or provide asynchronous sampling to 660 MHz. The 8-channel module provides both synchronous and asynchronous sampling at 100 MHz. And the 32-channel or 24-channel module can be used to arm the trigger on those modules with higher acquisition rates.

To back it all up, there's powerful triggering, clock and trigger qualification, programmable reference memory and multiple clocks. There is glitch triggering, with a separate glitch memory for unambiguous glitch detection and our unique "arms mode" that allows precise timing correlation between synchronous and asynchronous data.

Arms mode allows the DAS 9100 to capture synchronous and asynchronous data simultaneously. The data is displayed in the correct time relationship for easy analysis in either Timing or State Display mode. To obtain the data width and speed your application requires, simply select the appropriate combination of modules and add on later as your needs change.

To enhance the tool set, the define mnemonics menus allow the user to build disassembly tables to support proprietary and other non-supported chips. Up to 64 tables with 256 entries per table can be nested to provide the capability to support complex 16-bit processors, with room left over!

Pattern generation makes it possible to start debugging hardware before your software, or all of your hardware, is available.

Pattern generation capability is built around a 16-channel, 25 MHz controller module. Through additional expansion modules, you can increase the total to 48 or 80 channels while maintaining full system speed. The pattern generator allows interaction with the prototype through clock outputs, data strobes, an external clock, and external control inputs, including an interrupt line. And, the pattern generated can even be changed, based on the data acquired by the logic analyzer, through the external control lines.

The DAS 9100 also offers you powerful I/O options, including a built-in magnetic tape cartridge drive (Option 01) to store instrument setups, pattern sequences, mnemonics and reference memory. The RS-232 and GPIB interface (Option 06) offers complete remote programmability and supports hard copy units, video displays and serial line printing. It enhances high-speed GPIB for ATE applications up to 200 kbytes per second transfer rate. Option 06 also provides an RS-232 line printer port for the DAS to allow for easy documentation of menu displays, EDM tables, state tables and timing diagrams.

Options 03 and 04 allow you to add one or two additional modular power supplies (each supply powers two slots). The standard DAS mainframe comes with a power supply for two slots. You only pay for the capability you need.

**See page 114 for DAS 9100 module and option selection guide.**

## DAS 9100

### SOFTWARE ANALYSIS MICROPROCESSOR & BUS SUPPORT

**91A24 and 91AE24**

**DATA ACQUISITION MODULES**

- 16 Level Sequential Trigger Tracing
- Data Storage Qualification with up to 4 Word Recognizers
- 32 Bit Counter/Timer with 100 ns Resolution
- 24 Data Channels with 1 K Memory Depth
- 3 External Clocks and 3 Qualifiers with Independently Programmable Expressions
- Single Probe Demultiplexing
- Synchronous or Asynchronous Acquisitions Down to 100 ns Data Cycles
- Supports Over 30 Microprocessors and Buses with 91TMXX Support Series (Page 123)

For software analysis, the 91A24 data acquisition module provides advanced triggering and clocking. It employs five independent word recognizers which include a 16 level stack that lets you build the complex triggers and data qualifiers necessary to debug involved software routines.

**Maximum Modules Per DAS** — One 91A24 maximum per DAS mainframe, three 91AE24 expansion units maximum per DAS mainframe (requires 91A24 to operate).
**Maximum Number of Inputs** — 24 data channels expandable to 96 channels with one 91A24 and three 91AE24 modules.
**Maximum Sampling Rate** — 10 MHz internal or external clock, 100 ns cycle time.
**Memory Depth** — 1023 bits per channel.
**Reference Memory** — 1 k by 48 channels formattable to 512 by 96 channels, compare with acquisition, trigger on compare equal or not equal, column masking and programmable compare window.
**Clock Qualifiers** — Three available on 91A24 only. Selectable polarity for each of three POD clock expressions.
**Clock** — Selectable from one internal or three external sources.
Internal: 100 ns to 5 ms ±01% ±01 ns.
External: Three clock inputs, 20 MHz maximum, selectable rising or falling edge for each of three independent Boolean clock expressions, one expression per POD memory, [(CLK1 • Q1) + (CLK2 • Q2) + CLK3] • Q3, Demultiplex mode with 50 ns DEMUX interval minimum and 100 ns cycle minimum.
**Triggering** — Five independent word recognizers with selectable operating modes:
WR1 — Begin store or store only data qualifier.
WR2 — Begin store or store only data qualifier or parallel trigger event.
WR3 — 16 level sequential trigger stack with occurrence counter and sync output or counter/timer control option at each stack level.
WR4 — END store data qualifier, RESET stack operation, or OFF.
WR5 — END store data qualifier or OFF.
External trigger enable input and trigger sync output.
**Trigger Positioning** — BEGIN, CENTER, END, or DELAY 1 to 32,767 clocks
**Trigger Arming** — Arms 91A08 or 91A04A.
**Event Counter** — Counts from 1 to 4,096 events programmed on individual stack levels.
**Probes** — P6460 or P6462, three per module; mixing probes is not recommended.
**Data Set Up Time** — 25 ns minimum using P6460, 29 ns minimum using P6462.
**Data Hold Time** — 0 ns maximum using P6460, 3 ns maximum using P6462.
**Qualifier Set Up Time** — 25 ns minimum using P6460, 29 ns minimum using P6462.
**Qualifier Hold Time** — 0 ns maximum using P6460, 3 ns maximum using P6462.
**Counter/Timer** — 32 bit, 100 ns resolution START or STOP from stack levels.

### SOFTWARE & HARDWARE ANALYSIS GENERAL PURPOSE 25 MHz SUPPORT

**91A32**

**DATA ACQUISITION MODULE**

- 32 Channel Data Width
- Synchronous or Asynchronous Sampling to 25 MHz
- 3 Word Recognizers with Occurrence Counter
- 2 Clock Qualifiers and Expandable Clocking
- Arms 91A08 and 91A04A

In many instances, the engineer's goal is to monitor overall logic activity on the system bus. Here the 91A32 data acquisition module becomes an ideal choice. It combines a 32-channel data width with sample rates up to 25 MHz. To define and capture various types of bus transactions, each 91A32 module has three levels of triggering and two clock qualifiers. Up to three 91A32 modules may be used in a single DAS mainframe, for a total of 96 parallel channels.

**Maximum Modules Per DAS** — Three 91A32 modules max per DAS mainframe.
**Maximum Number of Inputs** — 32 data channels expandable to 96 channels with three modules.
**Maximum Sampling Rate** — 25 MHz internal or external clock, 40 ns cycle time.
**Memory Depth** — 512 bits per channel.
**Reference Memory** — 512 bits/channel, compare with acquisition, trigger on compare equal or not equal, column masking and programmable compare window.
**Clock Qualifiers** — Two per module six maximum, selectable polarity.
**Clock** — Selectable from one internal or up to three external sources.
Internal: 40 ns to 5 ms ±01% ±01 ns.
External: Selectable rising or falling edge, demultiplex split clock mode available with two or three 91A32 modules.
**Triggering** — Three word recognizers, two provide sequential or independent triggering with occurrence counter, one provides independent reset function. External trigger enable input and word recognizer output.
**Trigger Positioning** — BEGIN, CENTER, END or DELAY 1 to 32,767 clocks.
**Trigger Arming** — Arms 91A08 or 91A04A.
**Event Counter** — Counts from 1 to 32,767 word recognizer events.
**Probes** — P6452 or P6462, four per module; mixing probes is not recommended.
**Data Setup Time** — 29 ns minimum using P6452, 25 ns minimum using P6462.
**Data Hold Time** — 0 ns maximum using P6452, 7 ns maximum using P6462.
**Qualifier Setup Time** — 29 ns minimum using P6452, 25 ns minimum using P6462.
**Qualifier Hold Time** — 0 ns maximum using P6452, 7 ns maximum using P6462.

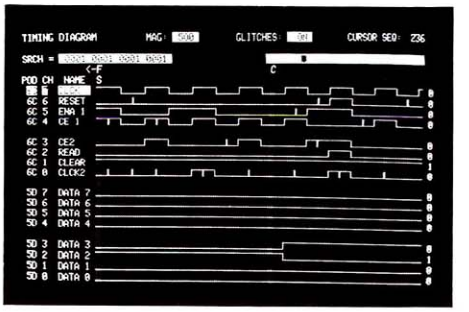
### HARDWARE ANALYSIS GENERAL PURPOSE 100 MHz SUPPORT

**91A08**

**DATA ACQUISITION MODULE**

- Synchronous or Asynchronous Sampling to 100 MHz
- 8 Channel Data Width Expandable to 32 Channels
- 5 ns Glitch Trigger and Storage
- Separate Glitch Storage Memory
- Trigger Arming From 91A24 or 91A32

Many applications call for asynchronous sampling to observe the status of control lines during bus transactions. For this purpose, the 91A08 data acquisition module serves as an ideal tool. Each 91A08 gives you 8 data channels at sample speeds up to 100 MHz and independent glitch triggering. A single DAS mainframe will accept four of these modules for a total of 32 channels at 100 MHz.




*91A08 Timing diagram with glitches*

**Maximum Modules Per DAS** — Four 91A08 modules maximum per DAS mainframe.
**Maximum Number of Inputs** — Eight data channels expandable to 32 channels with four modules.
**Maximum Sampling Rate** — 100 MHz internal or external clock, 10 ns cycle time.
**Memory Depth** — 512 bits per channel with separate 512 bits per channel for glitch storage.
**Reference Memory** — 512 bits per channel, compare with acquisition, trigger on compare equal or not equal, column masking and programmable compare window.
**Clock Qualifier** — One per module, four maximum, selectable polarity.
**Clock** — Selectable from two internal or two external sources.
Internal: 10 ns to 50 ms ±01% ±01 ns.
External: Selectable rising or falling edge.
**Triggering** — Single level word recognizer and glitch recognizer. External trigger enable using arms mode.
**Trigger Positioning** — BEGIN, CENTER, END or DELAY 1 to 32,767 clocks.
**Trigger Arming** — Armed by 91A24 or 91A32.
**Probes** — P6452, one per module.
**Data Setup Time** — ≤9 ns using one 91A08, ≤10 ns using multiple 91A08 modules.
**Data Hold Time** — 0 ns maximum.
**Qualifier Setup Time** — ≤9 ns using one 91A08, ≤10 ns using multiple 91A08 modules.
**Qualifier Hold Time** — 0 ns maximum.
**Glitch Storage** — 5 ns minimum glitch width.

## DAS 9100

### HARDWARE ANALYSIS HIGH-SPEED 330 MHz or 660 MHz SUPPORT

### 91A04A and 91AE04A

### DATA ACQUISITION MODULE

**1.5 ns Sample Interval in Two Channel Mode For 660 MHz Asynchronous Acquisition**

**Synchronous Aquisition to 300 MHz**

**Asynchronous Acquisition to 330 MHz on All 4 Channels**

**4 Data Channels With 2048 Bits Per Channel Memory Depth**

**4096 Bits Per Channel in Two Channel, 1.5 ns Mode**

**Trigger Arming From 91A24 or 91A32**

**Auto-Deskewing Minimizes Channel-To-Channel Skew and Ensures Optimum Setup and Hold Times**

For high-speed hardware analysis, select the 91A04A data acquisition module which delivers sample speeds up to 660 MHz, the fastest in the industry. This extremely fast asynchronous sample rate gives you a timing resolution of 1.5 ns, fast enough to actually capture and display glitches in their true timing relationship to other signals. Now you can truly analyze where those errant pulses originated.

**Maximum Modules Per DAS** — One 91A04A maximum per DAS mainframe, three 91AE04A expansion units maximum per DAS mainframe (requires 91A04A to operate).

**Maximum Number of Inputs** — Four data channels expandable to 16 channels with one 91A04A and three 91AE04A modules.

**Maximum Sampling Rate** — 660 MHz internal two channels only (1.5 ns sample interval), 330 MHz internal clock four channels (3 ns cycle time), 300 MHz external clock four channels (3.3 ns cycle time).

**Memory Depth** — 2048 bits per channel; 4096 bits per channel in two channel 1.5 ns mode only.

**Reference Memory** — 512 bits per channel, compare with acquisition, trigger on compare equal or not equal, column masking and programmable compare window.

**Clock Qualifiers** — None.

**Clock** — Selectable from one internal or one external source.

Internal: 1.5 ns to 5 ms.

External: Selectable rising or falling edge.

**Triggering** — Single level word recognizer. (In 1.5 ns mode only trigger word must be valid for one sample period +2.5 ns). External trigger enable using arms mode.

**Trigger Positioning** — BEGIN, CENTER, END or DELAY by 1 to 32,767 clocks.

**Trigger Arming** — Armed by 91A24 or 91A32.

**Event Counter** — None.

**Probe** — P6453, one per module included.

**Data Setup Time** — 3.0 ns worst case adjustable in 400 ps increments.

**Data Hold Time** — 0.3 ns worst case adjustable in 400 ps increments.

**Qualifier Setup Time** — NA.

**Qualifier Hold Time** — NA.

**Channel to Channel Skew** — 0.50 ns on rising edges typical, 0.90 ns on falling edges typical.

**Minimum Detectable Pulse Width** — 3.5 ns worst case.

### PATTERN GENERATION GENERAL PURPOSE STIMULUS SUPPORT

### 91P16 and 91P32

### PATTERN GENERATOR MODULES

**Stimulus Data and Clock Rates to 25 MHz**

**Data Widths of 16, 48 or 80 Output Channels**

**Up to 10 Independently Programmable Strobes**

**Programmable Tri-State Output Control**

**External Pause, Tri-State, and Interrupt Control Inputs**

**Vector Count, Hold, Repeat, and Looping Operations**

**Vector Sub Routine, Nested up to 16 Levels**

Pattern generation makes it possible to start debugging hardware before your software, or all of your hardware, is available. The basic 91P16 Pattern Generator module gives you 16 channels of circuit stimulation at up to 25 MHz, and expansion modules can raise the total to 80 channels.

**Maximum Modules Per DAS** — One 91P16 maximum per DAS mainframe, two 91P32 maximum per DAS mainframe (requires 91P16 to operate).

**Maximum Number of Outputs** — 16 data channels and two strobes expandable to 80 data channels and 10 strobes with one 91P16 and two 91P32 modules.

**Maximum Stimulus Rate** — 25 MHz internal or external clock, 40 ns cycle time.

**Pattern Memory Depth** — 254 words or instructions, able to output over 65,000 unique patterns single pass or continuous.

**External Control Lines** — Three available from trigger time base probe.

**Pause** — Holds pattern output temporarily while asserted, selectable polarity.

**Inhibit** — Tri-States all outputs while asserted, selectable polarity.

**Interrupt** — Forces jump to subroutine after asserted. Selectable rising or falling edge.

**Clock** — Selectable from one internal or one external source and single step operation.

Internal: 40 ns to 5 ms ±01% ±01 ns.

External: Selectable rising or falling edge.

**Instruction Set** — Seven commands available to program sequence and pattern vector output.

**COUNT (N)** — Increment A pattern N times, one per clock.

**HOLD (N)** — Hold pattern output and inhibit clock for N cycles.

**REPEAT (N)** — Hold pattern output while generating N clock cycles.

**GOTO (LABEL)** — Output patterns starting at LABEL.

**CALL (LABEL)** — Call pattern subroutine at LABEL.

**RETURN** — Return from subroutine call.

**HALT** — Output pattern and inhibit clock.

**Number of (N) Variables** — Six maximum.

**Number of Labels** — 32 maximum.

**Number of Nested Subroutines** — 16 maximum.

**Number of Strobes** — Two strobe outputs on 91P16, four strobe outputs on 91P32.

**Strobe Pulse Polarity** — Selectable positive or negative.

**Strobe Delay Time** — Selectable from 70 ns to 40.910 μs in 40 ns steps.

**Strobe Pulse Width** — Selectable from 40 ns to 40.880 μs in 40 ns steps.

**Clock Output** — One clock line per probe, rising edge signifies beginning of cycle.

**Probes** — P6455 for TTL/MOS, P6456 for ECL, or P6457 for TTL/MOS with individual bit Tri-State. Two per 91P16 module, four per 91P32 module.

**Output Data Skew** — ≤10 ns.

**Output Clock Skew** — ±5 ns between different probes.

**Pause Pulse Width** — 19 ns minimum.

**Pause Hold Time** — 14 ns after output clock transition.

**Inhibit Delay Time** — 70 ns maximum.

**Interrupt Setup Time** — 7 ns minimum relative to external clock input, 72 ns minimum relative to output clock.

**Interrupt Latency** — 4 sequence execution delay.

### GPIB, RS-232, TAPE DRIVE, LINE PRINTER & HARD COPY SUPPORT

### OPTIONS 01 & 06

### COMMUNICATION INTERFACE OPTIONS

**High Speed GPIB (200 kbytes/second)**

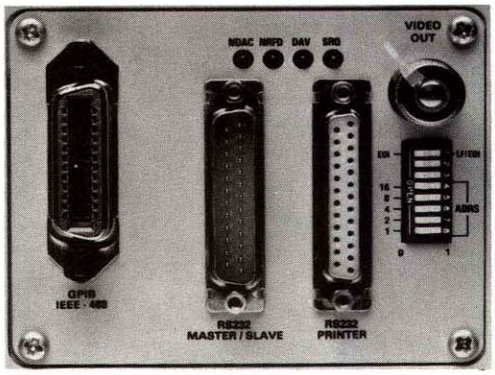
**RS-232 Host Interface**

**RS-232 Line Printer Port**

**RS-232 Master/Slave Operation**

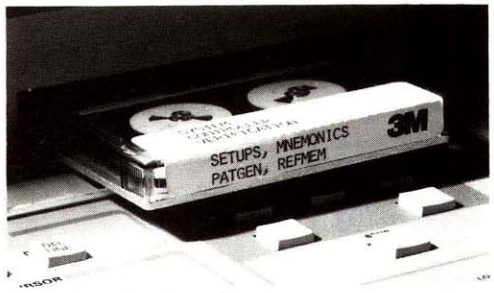
**Video Out/Hard Copy Support**
**DC 100 Tape Drive Local Storage**

The DAS Option 06 external communications package provides the most complete array of I/O capabilities to handle both computer and peripheral interfaces. It includes high speed GPIB, RS-232 master/slave, RS-232 printer port and hard copy interfaces. In the GPIB mode, host controller supplies all DAS menu setups and receives test results, with the DAS serving either as talker or listener. In the master/slave mode, one DAS acts as the master controller for a second DAS, which may be in a remote location and linked to the master DAS via modem. For stand-alone DAS installations, the RS-232 printer port and hard copy (video) output provide excellent documentation support for making copies of DAS menus and state or timing diagrams.




*Rear Communications Interface panel Option 06*

DAS 91DVV VLSI Verification Software uses the host communications capability of Option 06 to transfer test vector patterns to the DAS and to upload actual VLSI functional test data for host analysis.



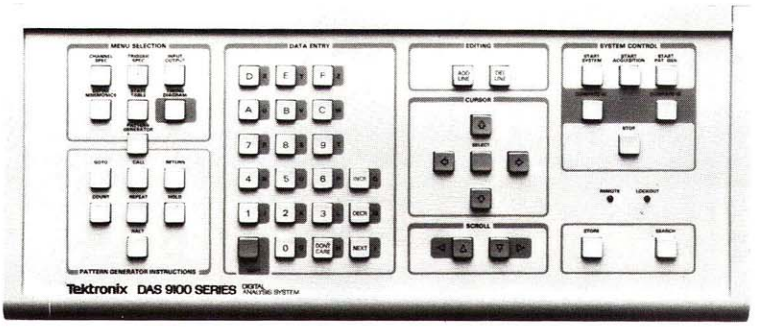

*DC 100 Tape Drive Option 01*

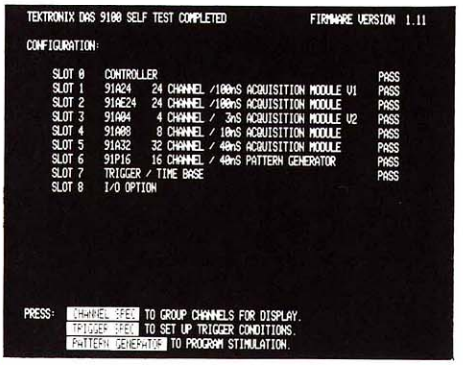
For workstation-type applications, the Option 01 built-in DC 100 tape drive provides convenient, menu-operated local storage and retrieval. It accepts tape cartridges (each holding up to 32 separate files) to store reference data, pattern generation programs, Extended Define Mnemonics tables or data acquisition setups.

# DAS 9100 SERIES

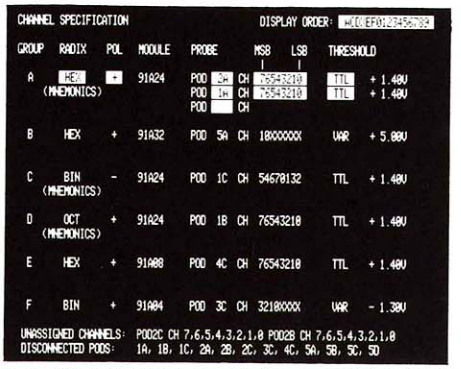
## The Leader in Flexibility and Ease of Use Through Superior Human Engineering

Besides color, the DAS 9100 includes many other important human engineering features. Its menu-driven, user interface is easy to learn and self-documenting, so there is no need to constantly refer to manuals. To complement the menu-driven displays, there is a color-coded keyboard organized specifically to enhance user programming. All keys are arranged into logical groups that correspond to the display elements they service.

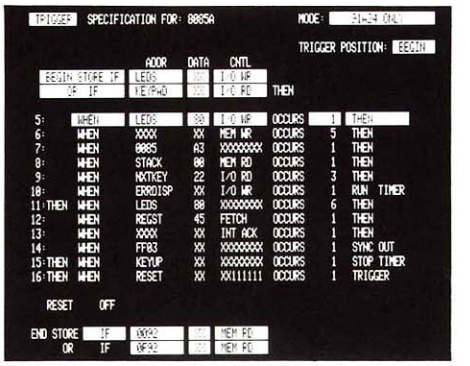


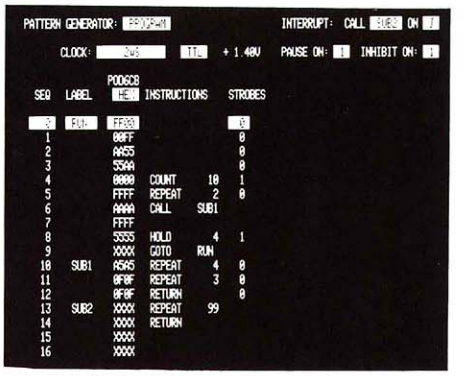

*Pull POWER ON: A configuration menu appears describing all card modules in the DAS by slot number location. A sophisticated self-test verification is performed on each module with pass/fail indication. Bottom of screen indicates next step.*



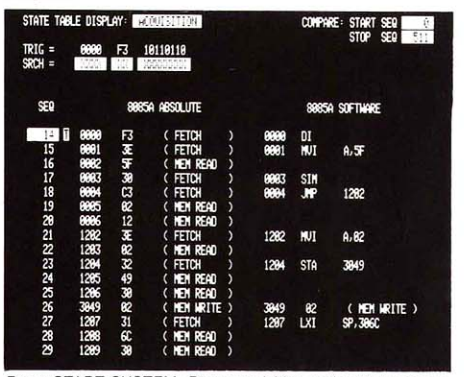

*Press CHANNEL SPEC: Through the use of CURSOR and DATA ENTRY keys all data acquisition channels are assigned to groups, a group radix is selected (hex, binary or octal), and individual probe pod thresholds and channel order are user assigned.*



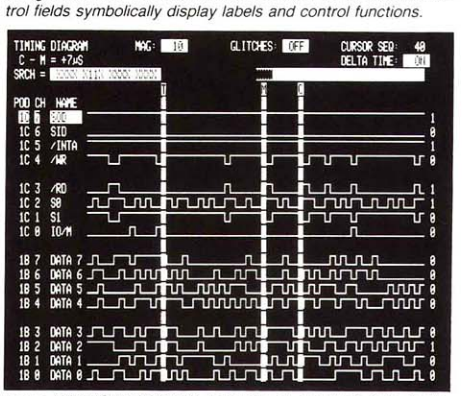

*Press TRIGGER SPEC: Use CURSOR SELECT key to scroll through all possible triggering combinations of data acquisition modules, including "ARMS MODE". The 91A24's five word recognizers with 16-level stack are shown. Address and control fields symbolically display labels and control functions.*



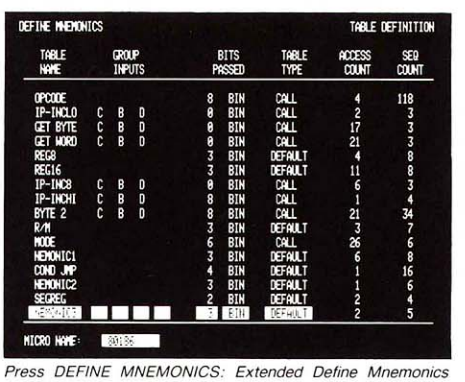

*Press PATTERN GENERATOR: This menu allows you to construct a pattern generation program 254 lines deep using English-language like commands. Labels maybe used to identify program segments and can be called from the main program providing sophisticated patterns for the debug of hardware or software.*



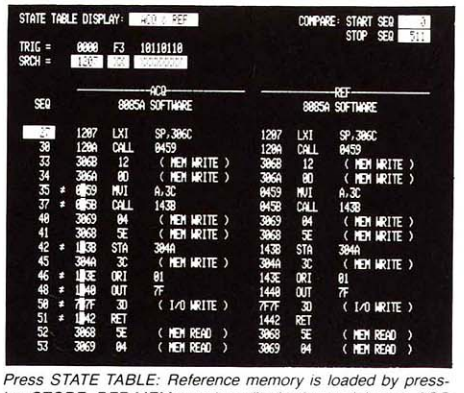

*Press START SYSTEM: Data acquisition and pattern generator modules are simultaneously started. When a trigger occurs the DAS immediately defaults to the STATE TABLE format display with the trigger word clearly indicated on screen. Acquisition or pattern generator modules may be started separately by using the START ACQUISITION or START PAT GEN keys.*



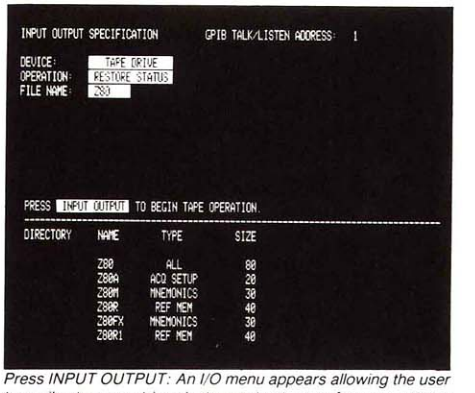

*Press TIMING DIAGRAM: Instantly all acquired data is displayed with trigger word clearly indicated. Use SCROLL keys to make DELTA-TIME measurements or CURSOR keys to turn glitches on or off. Select magnification values from X1 to X10,000. Add labels for each channel using DATA ENTRY keys.*




*Press DEFINE MNEMONICS: Extended Define Mnemonics (EDM) provides complete disassembly capability to the DAS state table display. You can use it to disassemble any type of acquired data, whether from microprocessors, mini- or microcomputer, or buses. EDM is controlled by three submenus accessed via the DEFINE MNEMONICS menu key.*




*Press STATE TABLE: Reference memory is loaded by pressing STORE. REF MEM may be edited prior to doing an ACQ MEM and REF MEM compare. Display ACQ MEM ONLY, REF MEM ONLY or both by using SELECT key. A SEARCH word may be entered and the search started by pressing the SEARCH key.*




*Press INPUT OUTPUT: An I/O menu appears allowing the user to easily store or retrieve instrument setups, reference patterns and mnemonic (EDM) files and to define parameters for GPIB, RS-232, Master/Slave and serial Line Printer operation.*

## DAS 9100 CHARACTERISTICS

### DATA FORMATTING

**Group Designations** — Up to 16 groups (1 to 32 channels per group).
**Display Order** — Designated group display order for state table.
**Channel Order** — Designated channel order within a group.
**Radix** — Octal, Binary, or Hexadecimal.
**Polarity** — Positive or negative (complement).
**Threshold** — Select TTL or variable.

### TRIGGERING

**Trigger** — Synchronous or Asynchronous.
**Trigger Word Position** — Begin, Center, End of Memory.
**Trigger Delay** — 1 to 32,767 clock samples.
**Trigger Word Display** — Hex, Binary, Octal, or mixed radix; any bits allowed as don't care (X).
**Trigger Modes (Word Recognition)**
Up to five word recognizers with sixteen level stack (module dependent, see individual acquisition module specs)
- External Trigger Enable (TTL)
- Word Recognizer Output (TTL)
- 91A32 arms 91A08 or 91A04A/91AE04A
- 91A24 arms 91A08 or 91A04A/91AE04A
- 91A32 and 91A08
- Compare until equal or not equal

**Glitch Recognizer (91A08 only)**
- Enable by channel
- OR'ed with 91A08 trigger word

**Clocks** — See individual module specs.
**Clock Qualifiers** — See individual module specs.

### DATA ACQUISITION DISPLAY MODES

**Timing Diagram Features**
- Simultaneous display of 16 user selectable channels
- User definable six-character trace labels for each displayed channel
- Data magnification factors from X1 to X10,000
- Cursor position and word readout in binary
- Search word
- Time aligned data display for arming mode
- Glitch display select (91A08 only)
- Horizontal data scrolling
- Memory display window
- Delta time measurement cursors

**State Table Features**
- Hex, Binary, Octal, or mixed radix
- Definable mnemonics displayed by group in acquisition/reference memory displays
- Search word
- Time-aligned data display for arms mode
- Vertical or block scrolling
- Cursor position
- Up to 1023 bits by 96 channels reference memory display, with or without data acquisition display
- Reference memory editing
- Programmable compare window
- Reference memory mask word capability
- Compare mode — highlighted and flagged for differences

**Extended Define Mnemonics**
- Software disassembly mode
- Hardware disassembly mode
- Absolute disassembly mode
- Simultaneous display of any two modes
- (Dependent on processor and mode selected)

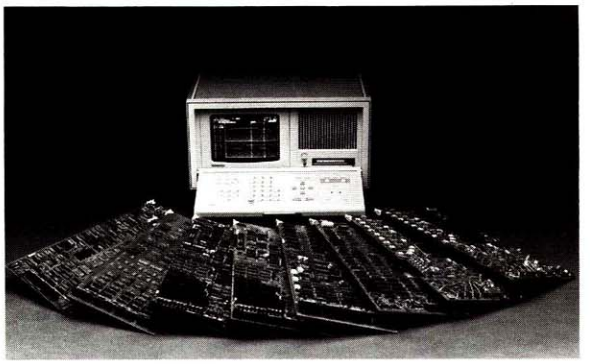
Up to 64 nestable tables with 256 entries per table. More than sufficient to completely disassemble 80186 and 68000 type processors.

### KEYBOARD

The DAS 9100 keyboard is divided into four sections for ease of use and functionality. Menu keys, data entry keys, edit and cursor control, and system control keys provide total control at your fingertips.

### I/O SUMMARY

**DC 100 Tape Drive (Option 01)**
Stores six full instrument setups or 20 different reference memory patterns. Directory space for 32 files.
**RS-232 (Option 06)**
Selectable Baud Rates: 300, 600, 1200, 2400, 4800, 9600.
Master/Slave Operation: Full Duplex, Asynchronous



**GPIB (Option 06)**
Talker/Listener Only.
Selectable Address.
Selectable Controller Type, EOI or (LF or EO1).
**Line Printer Output (Option 06)**
Prints both state and timing diagram.
RS-232 serial printers supported.
Selectable baud rates to 9600 baud.
Supports CTRL/S and CTRL/Q handshaking (X-on/X-off).
**Composite Video Output (Option 06)**
Hardcopy interface.
Video monitor interface.

### OTHER CHARACTERISTICS

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 432 | 17.0 |
| Height | 241 | 9.5 |
| Depth | 597 | 23.5 |
| **Weight** | **kg** | **lb** |
| Without Accessories | 21.8 | 48.0 |

**LO Line** — 90 V to 132 V RMS.
**HI Line** — 180 V to 264 V RMS.
**Line Frequency** — 48 Hz to 63 Hz.
**Power** — 1000 VA, maximum.
**Temperature Range** — Operating: 0°C to +50°C (+32°F to +122°F).
Storage: −40°C to +65°C (−40°F to +149°F).
**Altitude** — Operating: 10,000 ft maximum.
Storage: 50,000 ft. maximum.

### INCLUDED PROBE ACCESSORIES

P6452 probe, 1 ea; P6454 external clock probe, 1 ea.

## ORDERING INFORMATION

### MAINFRAME ONLY

**DAS 9109** Monochrome Mainframe ... **$5,500**
**DAS 9119** ATE Mainframe (Deletes CRT and Keyboard; Adds Option 06) ..... **$6,350**
**DAS 9129** Color Mainframe ..... **$8,400**

### MAINFRAME OPTIONS

**Option 01** — DC-100 Tape Drive ..... +**$1,450**
**Option 03** — One Additional Power Supply ..... +**$800**
**Option 04** — Two Additional Power Supplies ..... +**$1,600**
**Option 05** — Rackmount Hardware ..... +**$200**
**Option 06** — High-Speed GPIB, Serial Line Printer Port ..... +**$1,550**
**Option 88** — Mainframe shipped with modules installed and checked out as part of the mainframe ..... **NC**

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro, 220 V/16 A, 50 Hz
**Option A2** — UK, 240 V/13 A, 50 Hz
**Option A3** — Australian, 240 V/10 A, 50 Hz
**Option A4** — North American, 240 V/15 A, 60 Hz
**Option A5** — Switzerland, 220 V/10 A, 50 Hz

### MAINFRAME FIELD INSTALLABLE OPTIONS

**DAS 91F1** — Field Installed Option 01 (Includes Installation in Service Center) ..... **$1,700**
**DAS 91F3** — Field Installed Additional Power Supply ... **$800**
**DAS 91F6** — Field Installed Option 06 (For Mainframes Above S/N B020100) ..... **$1,700**
**Option 01** — Field Installed Option 06 (For Mainframes Below S/N B020100) ..... **NC**

### MAINFRAME MODULES

The following modules include probes. See probe selection guide at end of this order section and pages (129 through 132) for additional module and probe selection information. Maximum of six modules per mainframe, 104 data acquisition channels and 80 pattern generator channels.

**91AE04A** — Data Acquisition Expansion Module ..... **$5,950**
**91AE24** — Data Acquisition Expansion Module ..... **$4,700**
**91A04A** — Data Acquisition Module ..... **$7,950**
**91A08** — Data Acquisition Module ..... **$3,985**
**91A24** — Data Acquisition Module ..... **$4,990**
**91A32** — Data Acquisition Module ..... **$4,990**
**91P16** — Pattern Generator Module ..... **$3,990**
**91P32** — Pattern Generator Expansion Module ..... **$6,900**

**Note: When adding modules, check that the correct number of power supplies are also selected. The mainframe includes sufficient power for two modules. One additional power supply (Option 03) is required for three or four modules. Two additional power supplies (Option 04) are required for a total of five or six modules.**
**Microprocessor/Bus support: For ordering information please see page 123.**

### PROBES

**P6452** — Eight Channel Data Acquisition Probe ..... **$730**
**P6453** — Four Channel High-Speed Data Acquisition Probe ..... **$1,560**
**P6454** — External Clock Probe For 91A08 Modules. (Only one required, included with each DAS 9100 Mainframe.) ..... **$265**
**P6455** — Eight Channel TTL/MOS Pattern Generator Probe ..... **$575**
**P6456** — Eight Channel ECL Pattern Generator Probe **$575**
**P6457** — Four Channel Tri-State Pattern Generator Probe ..... **$575**
**P6460** — Eight Channel Data Acquisition Probe ..... **$700**
**P6462** — Eight Channel TTL Only Data Acquisition Probe ..... **$340**

### PROBE SELECTION GUIDE

| DAS Module | No. Probes Required | Included As Standard | Optionally Available |
|---|---|---|---|
| 91A04A | 1 | P6453 | |
| 91AE04A | 1 | P6453 | |
| 91A08 | 1 | P6452 | |
| 91A24 | 3 | P6460 | P6462 |
| 91AE24 | 3 | P6460 | P6462 |
| 91A32 | 4 | P6452 | P6462 |
| 91P16 | 2 | P6455 | P6456, P6457 |
| 91P32 | 4 | P6455 | P6456, P6457 |

### OPTIONAL ACCESSORIES

**DAS Setup and Hold Calibration Fixture** — Order 067-1037-00 ..... **$1,200**
**High Speed Acquisition Test Fixture for 91A04A** — Order 067-1139-00 ..... **$250**

For additional accessories please see pages 129 thru 132.

**Select the Performance and Price That Meets Your Application Need.**
The DAS 9100 is a modular architecture system designed to keep you state-of-the-art as your application needs change and grow. The modular DAS 9100 mainframe accepts up to six modules chosen from the selection of Data Acquisition and Pattern Generation modules listed on page 110 and 111.

The standard DAS 9100 mainframes with their associated options are shown on page 113. These DAS 9100 mainframes come standard with two module slots already powered. Options 03 and 04 allow you to add one or two power supplies, with each power supply providing power for two additional module slots. You only pay for the capability you need.

The Standard Configurations shown below provide an easy way to order a DAS already configured for your application. Use the chart below to match your application with the appropriate standard configuration.

**Microprocessor Support.**
The widest Selection of microprocessor support packages in the industry is listed on page 123.

## DAS 9100 STANDARD CONFIGURATIONS ORDERING GUIDE

| Standard Configuration Model Number | | Recommended Application | Acquisition Modules | Pattern Generation Modules | Options Included | Performance Features |
|---|---|---|---|---|---|---|
| Color Display | Monochrome Display | | | | | |
| **DAS 9121 $16,370** | **DAS 9101 $13,470** | General Purpose Hardware Analysis | Two 91A08 | | | 16 Channel 100 MHz Data Acquisition |
| **DAS 9122 $17,380** | **DAS 9102 $14,480** | General Purpose Acquisition With Stimulus | One 91A32 | One 91P16 | | 32 Channel 25 MHz Data Acquisition<br>16 Channel 25 MHz Pattern Generation |
| **DAS 9123 $22,165** | **DAS 9103 $19,265** | General Purpose Software/Hardware Integration | One 91A32<br>One 91A08 | One 91P16 | Opt 03 Power | 32 Channel 25 MHz Data Acquisition<br>8 Channel 100 MHz Data Acquisition<br>16 Channel 25 MHz Pattern Generation |
| **DAS 9124 $33,390** | **DAS 9104 $30,490** | Expanded Software/Hardware Integration | Two 91A32<br>Two 91A08 | One 91P16 | Opt 01 Tape<br>Opt 04 Power | 64 Channel 25 MHz Data Acquisition<br>16 Channel 25 MHz Pattern Generation<br>16 Channel 25 MHz Pattern Generation<br>DC 100 Tape Mass Storage |
| **DAS 9125 $19,540** | **DAS 9105 $16,640** | General Purpose Microprocessor Support | One 91A24<br>One 91AE24 | | Opt 01 Tape | 48 Channel 10 MHz Data Acquisition<br>DC 100 Tape Mass Storage |
| **DAS 9126 $24,550** | **DAS 9106 $21,650** | High Speed Hardware Analysis | One 91A04A<br>One 91AE04A | | Opt 01 Tape<br>Opt 03 Power | 4 Channel 660 MHz or<br>8 Channel 330 MHz Data Acquisition<br>DC 100 Tape Mass Storage |
| **DAS 9127 $28,315** | **DAS 9107 $25,415** | Microprocessor Software/Hardware Integration | One 91A24<br>One 91AE24<br>One 91A08 | One 91P16 | Opt 01 Tape<br>Opt 03 Power | 48 Channel 10 MHz Data Acquisition<br>8 Channel 100 MHz Data Acquisition<br>16 Channel 25 MHz Pattern Generation<br>DC 100 Tape Mass Storage |
| **DAS 9128 $45,760** | **DAS 9108 $42,860** | Interactive ATE: VLSI Verification | Three 91A32 | One 91P16<br>Two 91P32 | Opt 01 Tape<br>Opt 04 Power<br>Opt 06 Comm | 96 Channel 25 MHz Data Acquisition<br>80 Channel 25 MHz Pattern Generation<br>DC 100 Tape Mass Storage<br>GPIB/RS-232 Communications Interface<br>Serial Line Printer Port<br>Display Video Output |
| **DAS 9118 $40,710** with DAS 9119 ATE mainframe | | Remote Only Operation; Display and Keyboard Not Included | Three 91A32 | One 91P16<br>Two 91P32 | Opt 04 Power<br>Opt 06 Comm | 96 Channel 25 MHz Data Acquisiton<br>80Channel 25 MHz Pattern Generation<br>CRT and Keyboard Deleted<br>GPIB/RS-232 Communications Interface<br>Serial Line Printer Port<br>Display Video Output |

## DAS PERFORMANCE SUMMARY GUIDE

| Module Name | Type | Channels | Maximum Channels | Memory Depth | Speed | Application |
|---|---|---|---|---|---|---|
| **91A04A/91AE04A** | Acquisition | 2/4 | 16 | 4096/2048 | 660/330 MHz | High Speed Hardware Analysis |
| **91A08** | Acquisition | 8 | 32 | 512 | 100 MHz | Hardware Analysis |
| **91A32** | Acquisition | 32 | 96 | 512 | 25 MHz | Hardware/Software Analysis |
| **91A24/91AE24** | Acquisition | 24 | 96 | 1023 | 10 MHz | Sophisticated Software Analysis |
| **91P16/91P32** | Pattern Generator | 16/32 | 80 | 254 | 25 MHz | Hardware/Software Simulation |

NEW

## 91DVV DesignLink® DAS VLSI VERIFICATION SOFTWARE PACKAGE

**Links DAS 9100 to VAX Host for Bench-Top VLSI Testing**

**Uses Logic-Simulation Test Vectors for Prototype Test**

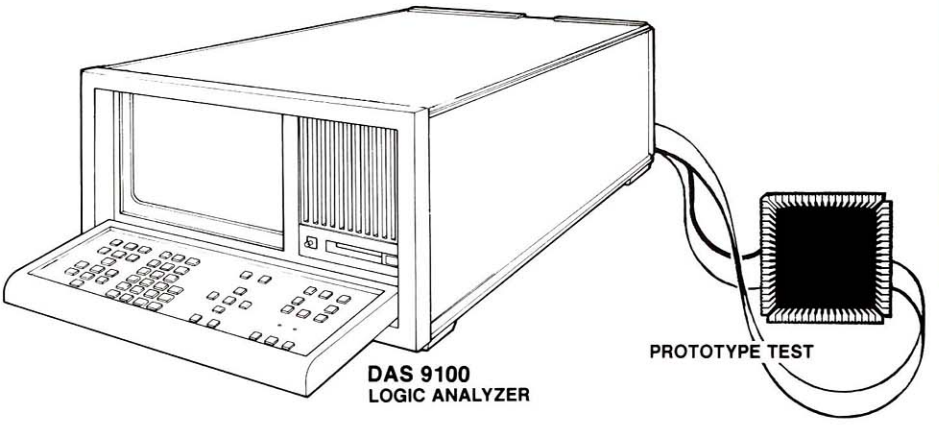
**Vector Compression Increases Effective DAS Pattern Generator Depth**

**Compares Predicted Outcomes to Actual Prototype Responses**

**Rapid Setup Changes for Different Users and Prototypes**

**C Source Code Operates in UNIX 4.1 bsd Environment**

**Modular Software is Easily Installed and Portable**




The 91DVV DesignLink® DAS VLSI Verification Software is based on the UNIX software environment, and is designed to provide communications capabilities between a VAX host and the DAS 9100 Series digital analysis system. 91DVV is an easily set up and low-cost alternative to production test systems for prototype device verification.

91DVV enables hosted programming of pattern generation, data acquisition, and comparison between predicted and actual device responses. The 91DVV software converts test-vector tables into compressed DAS pattern generator programs, which it then downloads to the DAS for stimulation of the device. The protoype's resulting outputs are acquired by the DAS and uploaded to the host, where 91DVV compares the actual to predicted responses.

91DVV is an especially well-suited tool for creating an IC design-simulation and prototype-test system. 91DVV saves you time and promotes development continuity by using test vectors already developed for logic simulation. This also helps in verifying the simulation software's performance.

The 91DVV software package is straightforward to use. Hardware setup consists of connecting DAS pattern generator and data acquisition probes to a powered test fixture, which holds the prototype device. The 91DVV software automatically queries the DAS to determine the current DAS hardware configuration, and uses the information to set up the prototype test and comparison. A prompting dialogue helps you set up clocking, tri-state control, and vector-to-pin mapping.

The 91DVV software modules convert the test vectors into the DAS format and download them to the DAS pattern generators. The DAS exercises the prototype device and collects the responses, which 91DVV uploads to the host. 91DVV compares predicted responses to those actually acquired by the DAS, and outputs the results as a formatted listing. Test setups, routines, and results may be stored on the host, allowing rapid setup changes for multiple prototypes and users.

### 91DVV SOFTWARE MODULES

91DVV software is composed of several modules which act as UNIX shell commands. See Figure 1.

### TLOGS2PAT

Converts a logic simulator's stimulus/response vector files into an easily processed intermediate format.

### DASXFER

Converts the intermediate vector file into a form the DAS can use in its specific configuration.

### DASPAC

Compresses the DASXFER output and compiles it into DAS binary packets. DASPAC supports the entire DAS pattern generator instruction set, including REPEAT, COUNT, HOLD, GOTO, CALL, RETURN, and HALT. It also supports labels used for GOTO and CALL references.

### PUTPAC

Downloads DAS binary packets from the UNIX environment to the DAS.

### GETACQ

Uploads contents of the DAS acquisition memory (up to 104 channels) to the UNIX environment.

### CMPACQ

Compares predicted device responses to the outputs acquired by the DAS.

### GETPAC

Uploads DAS binary packets to the UNIX environment.

### ADVANCED UTILITIES

Two advanced DAS utilities; SENDD and BDUMP are included with 91DVV to aid installation and debugging.

### DAS LIBRARY ROUTINES

The DAS library is a set of low-level routines that provide straightforward access to the DAS. The routines support binary block expansion and compression, DAS system control, and low-level I/O functions.

### TRI-STATE SUPPORT

The 91DVV software supports use of P6457 tri-state pattern generator probes, and also supports two methods for controlling customer-supplied tri-state buffers.

### OPERATING ENVIRONMENT

91DVV runs on the VAX 782, 780, 750, 730, and 725 mainframes. It requires the UNIX 4.1 bsd (Berkeley) operating system. As source code is provided, the advanced user can adapt 91DVV to other UNIX versions. 91DVV is customer installed. UNIX makefiles are provided to ease system installation, compilation, and documentation.

### COMPATIBILITY

91DVV can be modified to read any logic simulator's test vectors when output as a standard UNIX text file. 91DVV is supplied with an example simulator-to-91DVV front-end module, and with a description of the intermediate file format used. 91DVV is compatible with all DAS mainframe configurations. All DAS keyboard and menu functions remain operable when used with 91DVV. DAS modules supported are: 91A32 and 91A08 data acquisition modules; 91P16 and 91P32 pattern generator modules. DAS probes supported are: P6452 and P6454 data acquisition probes; P6455, P6456, and P6457 pattern generator probes. 91DVV supports DAS Option 06 I/O communications options through the RS-232 link.

### ORDERING INFORMATION

**91DVV1F** DAS VLSI Verification Software Package (Release 1), TU-58 cassette tape ..... **$1,000**

**91DVV1G** DAS VLSI Verification Software Package (Release 1), Nine track ½ inch tape, 800 BPI density ..... **$1,000**

**91DVV1H** DAS VLSI Verification Software Package (Release 1), Nine track ½ inch tape, 1600 BPI density ..... **$1,000**

**Ask about 91DVV versions for other computers and operating systems.**

## GPIB IEEE-488 1240

The 1240 complies with IEEE Standard 488-1978, and with Tektronix *Standard Code and Formats*.

**Total Design Support: Hardware, Software, and Integration**

**Up to 72 Acquisition Channels**

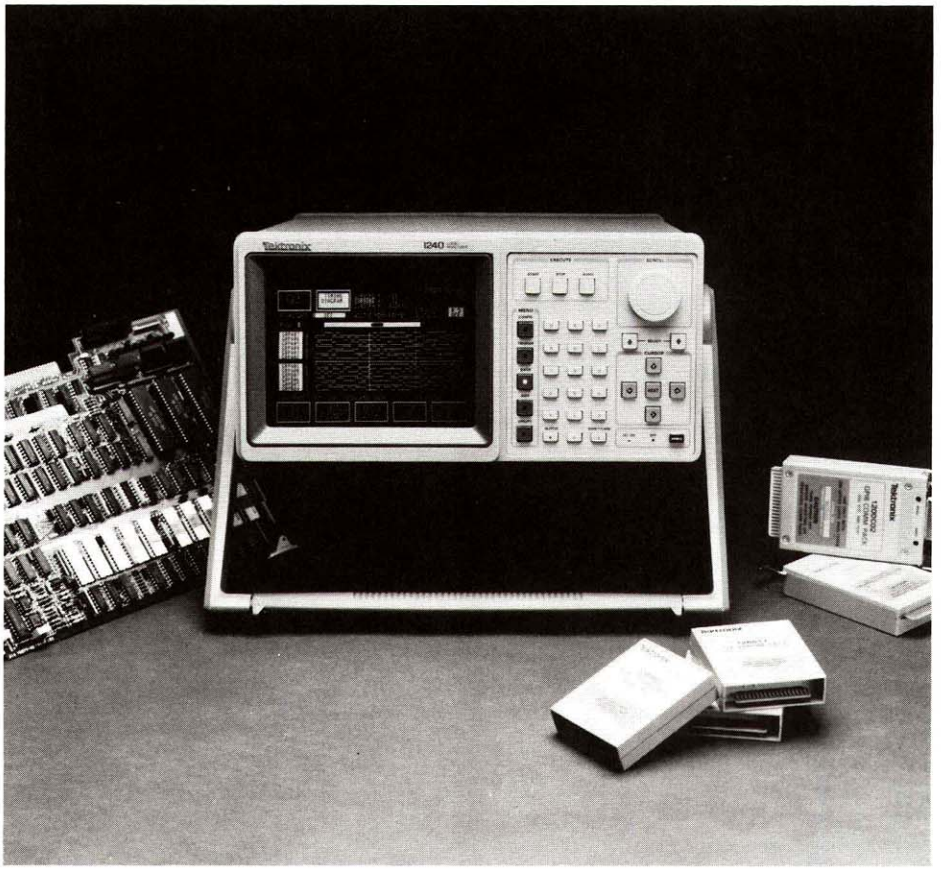
**Acquisition Speeds to 100 MHz Async, 50 MHz Sync**

**14 Levels of Triggering with Conditional Branching**

**Dual Timebase Triggering, Acquisition and Display**

**Simple Menu Operation With On-Screen Soft Keys**

**Transfers Easily into Manufacturing and Service**



## TOTAL PERFORMANCE

With the 1240 Logic Analyzer, the key phrase is **total performance.** This one instrument provides complete support for all aspects of the design task, including hardware analysis, software analysis, and integration.

### Hardware Analysis

For hardware analysis, the 1240 offers up to 36 channels of acquisition at sampling rates of 100 MHz asynchronous and 50 MHz synchronous (see acquisition card descriptions). 6 ns glitch detection is also available.

Standard memory depth is 512 bits per channel, and this can be extended to a maximum of 2048 bits per channel by using a special memory chaining feature. This feature allows you to chain one card's memory to another, trading channel width for memory depth.

Superior hardware triggering capabilities include data and glitch triggering for isolating the problem area; clocked and unclocked triggering for capturing events that might not coincide with sample points; and counters, timers, and duration filters for triggering on the characteristics of a signal as well as its occurrence.

Auto-run capability is also provided. This feature allows you to track intermittents through continuous acquisitions. During the acquisitions, you can change parameters on the system under test and dynamically monitor their effects.

### Software Analysis

Software analysis is supported by up to 72 data channels at sampling rates of 50 MHz synchronous/asynchronous (see acquisition card descriptions). A flexible clocking scheme includes data demultiplexing without double-probing.

Powerful software triggering capabilities are provided so you can track program flow. Included are 14 trigger levels, conditional branching, counters, timers, and both program flow and data flow qualification. These functions are implemented in two independent event recognizers.

Other features that assist in software analysis are flexible channel groupings for display, standard display radices (including ASCII and EBCDIC), and an 8-level pattern search and memory compare with highlighting.

### Hardware/Software Integration

For integration, the 1240 offers a dual timebase system that brings together all of the above hardware and software analysis capabilities. This dual timebase system greatly speeds the hardware/software integration process since the acquisition, triggering, and display of two independent timebases are tied together. You can fully monitor the interaction between hardware and software, or monitor the relationship of two interdependent systems. All data displays are time-aligned and completely correlated. The dual timebase allows you to integrate functional modules, an increasingly important design task.

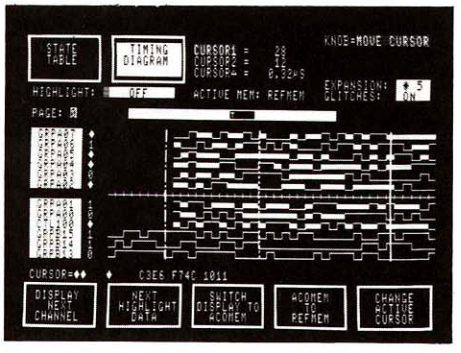



*Figure 1. Timing Diagram With Glitches.*

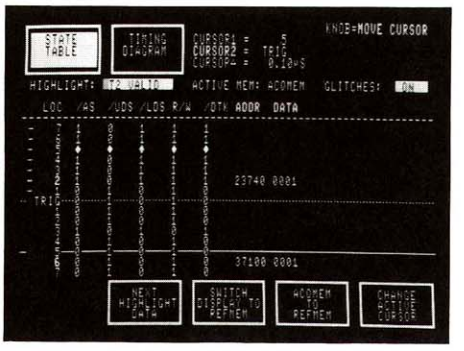



*Figure 2. State Table Display.*

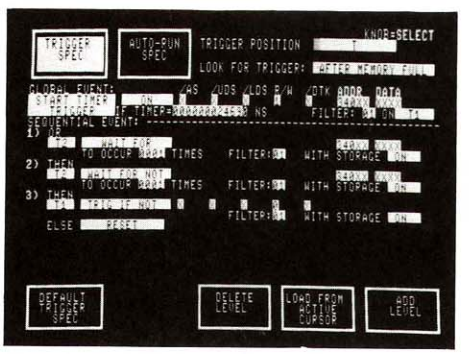



*Figure 3. Trigger Specification Menu.*

## FLEXIBILITY NOW AND IN THE FUTURE

The power of the 1240 stems from its configurable mainframe. This mainframe houses a selection of data acquisition cards and plug-in ROM and COMM Packs. You can select features that meet your current application needs, then later upgrade the mainframe to increased performance.

### Selectable Acquisition Cards

The 1240 mainframe provides four card slots that accommodate any combination of the following card types: 1240D1 and 1240D2.

The 1240D1 is a 9 channel data acquisition card that can sample at rates up to 100 MHz asynchronous and 50 MHz synchronous. This card also provides glitch capture down to 6 ns, on all channels.

The 1240D2 card is an 18 channel data acquisition card that can sample at rates up to 50 MHz asynchronous/synchronous. Another feature of this card is single-probe demultiplexing.

### ROM Packs for Data Processing

A ROM port on the side of the 1240 mainframe supports the addition of special software ROM Packs. With the 1240's acquisition capabilities, you have the capability to capture data which is very specific to your problem at hand. ROM Packs provide a means of helping you analyze that data, by processing it and presenting it to you in the most useful manner. Currently, there are ROM Packs supporting performance analysis, mnemonic disassembly of popular microprocessors, and special communications applications (see pages 118 to 120).

### COMM Packs for External Communications

Communication capabilities can be added to the 1240 by inserting COMM Packs into a communications port on the rear of the instrument. These COMM Packs act as adaptors, allowing the 1240 to function in different communication environments, including RS-232C and GPIB (see pages 119 and 120).

## EASE OF USE

In line with Tek's goal of easy-to-use logic analyzers, the 1240 human interface has been designed to facilitate the user's operation of the instrument.

### Menu Operation and Soft Keys

Ease of use starts with the 1240's menu operating system. Straightforward menu displays and on-screen soft keys allow you to make setup choices on the screen where your attention is already directed. You are not distracted by the need to look elsewhere on the instrument.

### Multiple Operation Levels

Another major feature of the menu operating system is user-selected operation levels. The 1240 provides four operation levels, ranging from basic operation for simple applications to full operation for complex applications. The sophistication of system features increases with the operation levels.

### Configurable From the Front Panel

The 1240 is completely configurable from the front panel, thus eliminating the need to switch boards and reconnect probes when changing from hardware to software applications. Probe connections are on the side of the instrument so they can be easily accessed. The keyboard has a simple layout, with single function keys. Also, a knob is included on the keyboard for data scrolling. This knob, along with the extreme smoothness of the data scrolling, make the 1240 displays easier to read and manipulate.

*Figure 4. Scroll Knob*

### Automatic Nonvolatile Storage

A battery-backed CMOS memory stores two complete instrument setups, including the last setup used before the 1240 is powered down. This facilitates quick instrument start-up when returning to work, and eliminates the problem of losing a setup as a result of power system interruptions.

## IDEALLY SUITED FOR ENGINEERING, MANUFACTURING, AND SERVICE

In addition to its usefulness in the engineering environment, the 1240 is well suited for manufacturing and service tasks. It transfers easily from one environment to another and helps facilitate communications between the different groups through its portability, remote control, mass storage and teleservicing capabilities.

### Portability

The 1240 weighs 12.0 kg (26.5 lb) and meets environmental Class 3 specifications. This makes it an ideal choice for a rugged logic analyzer that can be used in many locations.

### Remote Control

RS-232C and GPIB COMM Packs (see page 119), are ideally suited to automated test environments and remote control.

### Mass Storage

Mass storage of setups, acquisition memories, and reference memories is achieved through RAM and EPROM Packs. This type of pack storage allows engineering to easily transfer knowledge to other groups. They can create the setups and memories needed for design test in manufacturing, or they can create servicing procedures at the factory that can be sent out to field service sites.

Two types of pack storage are available. First, there is the 12RS01 8K RAM Pack. Storage and retrieval of information from this RAM Pack is accomplished via menu soft keys (see Figure 7). The 12RS11 32K EPROM Pack (no EPROM included) and the 12RS12 32K EPROM (EPROM included) provide a permanent storage medium for setups and memories. To store files on these EPROM Packs, the setups and memories are uploaded from the 1240 to a host via GPIB or RS-232C, and then burned into EPROMs.

### Teleservicing

Master-Slave capability allows one 1240 to remotely control another over a telephone line (see page 120). This greatly eases the higher levels of service troubleshooting, as service specialists can get to the problem via the telephone rather than having to physically travel to the problem site.



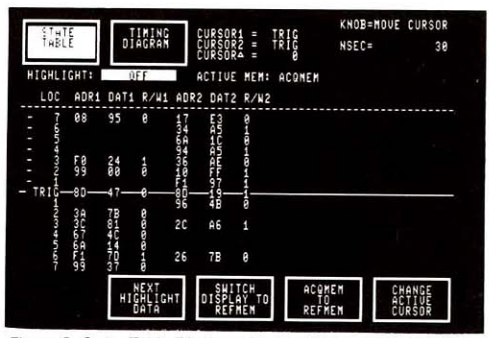



*Figure 5. State Table Display with Dual Timebase Acquisition.*

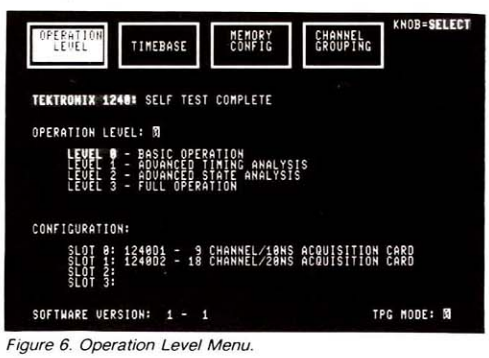



*Figure 6. Operation Level Menu.*

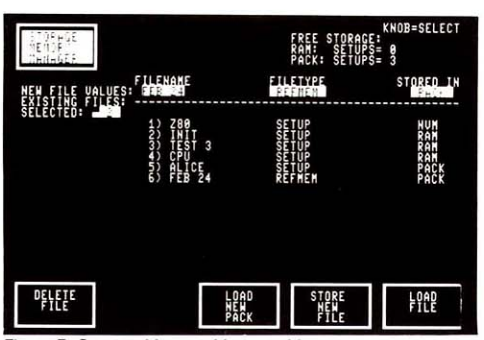



*Figure 7. Storage Memory Manager Menu.*

## 12RMXX

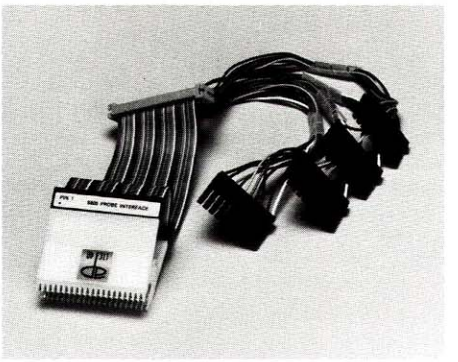
### Series Microprocessor Support

**Nineteen Processors Supported**

**Single-Plug Connection for Ease of Use and Reliability**

**State Table Display in Four Formats: State, Absolute, Hardware and Software**

**Cursor Readout in Timing Diagram Displayed in Disassembly Format**



The 1240 provides microprocessor support for major 8-bit and 16-bit processors. This support includes a single-plug interface, data acquisition capability and mnemonic disassembly.

For simple 8-bit and 16-bit processors, the 1240 uses its general purpose clocking and demultiplexing capabilities to acquire the data. Two 1240D2 cards using standard data acquisition probes (P6460 or P6462) are attached to the processor via a probe interface. See page 122 for information on the Configured Probe Interface. Three 1240D2 cards are required for the simple 16-bit processors.

For more complex 8-bit and 16-bit processors, the 1240 uses the PM200 Series of personality modules to interface to the processor and acquire the data for disassembly by the 12RMXX. These modules provide the special purpose hardware needed to properly acquire the instruction flow from a prefetch processor architecture and its associated internal queue. These modules plug directly into the 1240D2 cards, replacing the data acquisition probes and providing the interface to the processor. Three 1240D2 cards are required for these more complex processors. See page 122 for information on the PM200 Series.

The microprocessor disassembly support for the 1240 comes in the form of Mnemonics ROM Packs (12RMXXs), with one ROM Pack for each microprocessor.

Four disassembly formats are available for viewing the data after disassembly: State, Absolute, Hardware, Software.

State format is exactly the same as standard State Table format.

Absolute format augments the State format with cycle operation labels (FETCH WRITE, etc.).

Hardware format provides disassembly information for all cycles occurring on the bus (instructions or cycle labels on all acquired cycles.)

Software format displays the executed instructions. It is similar to Hardware disassembly format with the display of instruction read cycles which are not opcode fetches suppressed. DMA's and flushed instructions are also suppressed.

**The processors that are currently supported by the 1240 are:**

| | | |
|---|---|---|
| 6502/65C02 | 8080 | NSC800 |
| | 8085 | |
| 6800 | 8086 | Z80 |
| 6802 | 8088 | Z8001 |
| 6808 | 80186 | Z8002 |
| 6809 | 80188 | |
| 68000 | | |
| 68008 | F9450 | |
| 68010 | | |

For ordering information, please refer to the Microprocessor Support section on page 122.

## 12R01 Performance Analysis

**Two Types of Analysis: State Overview and Event Measurements**

**Monitor Memory Use, Execution Cycles, Subroutine Calls**

**Measure Time or Occurrences**

**Compare Statistics on Four Events, Analyze Distribution of Single Event**

**Measure Events Using Two Independent Timebases**

Performance analysis is a tool that assists engineers in the development of microprocessor-based products. It can be used throughout the life cycle of a product to help the designer characterize, test, debug, and optimize software and system activity.

The real benefit of performance analysis over other types of development tools is that it provides unintrusive overview measurements of system performance. In other words, it can be used to improve efficiency by providing measurements that characterize system performance without altering the performance.

The 12R01 Performance Analysis ROM Pack provides two types of performance analysis, State Overview and Event Measurement, for the 1240. These two types of analysis provide overviews of the activity of the system under test, graphically displaying this activity in the form of histograms.

**State Overview**

With State Overview, the user can acquire data on a set of defined ranges. Each range has a lower-bound value and an upper-bound value, and is defined for a specific group from the Channel Grouping menu. After a data acquisition is made (using the standard 1240 triggering) each cycle of the acquired data is searched to find any matches between the channel groups and the ranges defined for them. A match occurs any time the value of a group at a given cycle is greater than or equal to the lower-bound value and less than or equal to the upper-bound value of a range associated with that group.

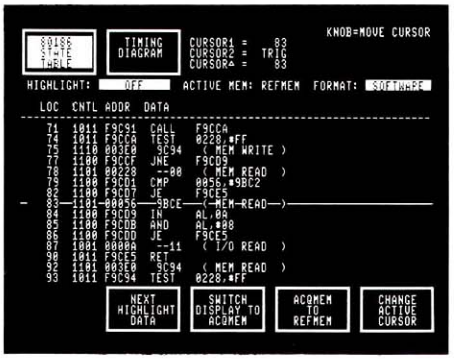



*Figure 8. 80186 Software Format.*

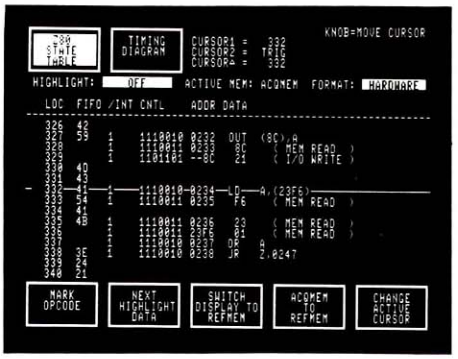



*Figure 9. Z80 Hardware Format with dual timebase acquisition.*

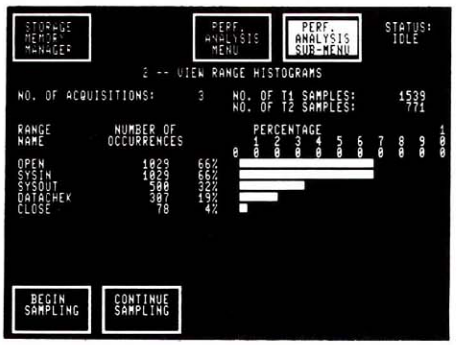



*Figure 10. View range histograms menu.*

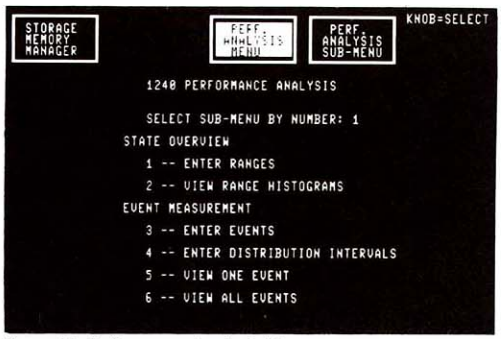



*Figure 11. Performance Analysis Menu.*

A cumulative count of the matches is kept for each range, and that count is displayed as a total count, a percentage of the total number of acquisition cycles on the associated channel group's given timebase, and as a bar graph (histogram) proportional in length to that percentage. Up to eleven ranges can be defined.

**Event Measurement**

With Event Measurement, the user is able to delimit the events that are to be analyzed. A measurement in this type of analysis consists of a start measurment event, an optional target event and a stop measurement event. The data acquired in a single occurrence of the start measurement/stop measurement cycle is defined as a "sample". When sampling begins, the 1240 repeatedly takes the same kind of measurement sample until the user stops the 1240. Within each sample, some type of measurement takes place, and this information is then processed for display.

The target event may be a single event that the user wishes to count occurrences of or time. It can also be two events, in which case the 1240 will measure the time between them. If no target event is chosen, the duration of each sample can be timed, or the number of clock cycles that occur on a given timebase during each sample can be counted. Up to four events can be defined.

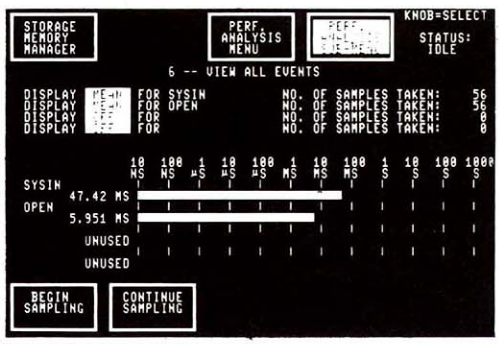



*Figure 13. View all events menu.*

# 1200CXX, 12RCXX

## Communications Support

### Line Printer Support for Most Printers

### Master/Slave Support

### Three Communication Interfaces

External communication capability is supported in the 1240 by means of modular COMM Packs. These COMM Packs, which plug into a COMM port on the back of the 1240, provide flexibility in interfacing the 1240 to other equipment.

**REMOTE CONTROL**

Two COMM Packs are provided to interface the 1240 to controllers, the 1200C01 RS-232C COMM Pack and the 1200C02 GPIB COMM Pack. The 1200C02 interface conforms to IEEE specification 488-1978, Standard Digital Interface for Programmable Instrumentation.

You can remotely control all of the capabilities of the 1240 using these COMM Packs.

The controller can start and stop data acquisitions and the auto-run function, write to the display, define custom soft keys, request 1240 keystrokes, initiate 1240 diagnostics, and request diagnostic results. Instrument setups, acquisition memories, reference memories and RAM Pack contents can be sent and received from the 1240, also.

Requests from the 1240 to upload and download setups and memories are initiated via soft keys (see figure 14).

The 1200C02 GPIB COMM Pack interface conforms to IEEE specification 488-1978, Standard Digital Interface for Programmable Instrumentation. The 1240 operates via the GPIB COMM Pack with the Tek 4041 controller.

**VIDEO OUT**

The 1240 comes equipped with an RS-170-compatible composite video signal of the current screen display.

**PRINTER SUPPORT**

Through the use of a ROM Pack and COMM Pack combination the 1240 is able to print hard copies of setup menus and data acquisition memories. Support will be provided for almost all commercially available low-cost printers. (See figure 15).

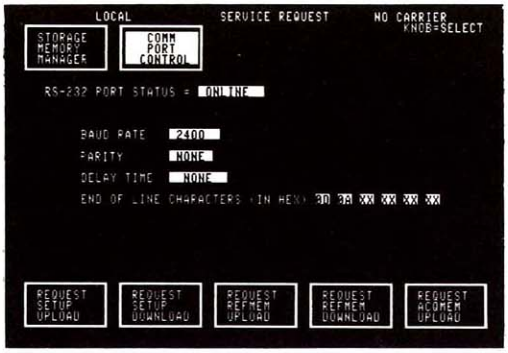



*Figure 14. COMM Port Control menu with a 1200C01 RS-232C COMM Pack installed.*

The printer interface consists of the combination of a ROM Pack and a COMM Pack. The 12RC01 Printer Support ROM Pack is used in combination with either the 1200C01 RS-232C COMM Pack (for printers with a serial interface) or the 1200C11 Parallel Printer COMM Pack (for printers with a parallel interface).

In normal operation, the Printer Support ROM Pack selects and prints only the relevant information from a chosen menu or data display. Soft keys, unused fields and blank lines are not printed. When menus or data displays are too long to be viewed in their entirety on a single 1240 screen, the Printer Support ROM Pack is able to print all relevant data.

Nearly all 1240 screen displays can be printed including Operation Level, Timebase, Memory Configuration, Channel Grouping, Trigger Spec, Auto-Run Spec, State Table, and Timing Diagram. In addition, a special combined state and timing format is available.

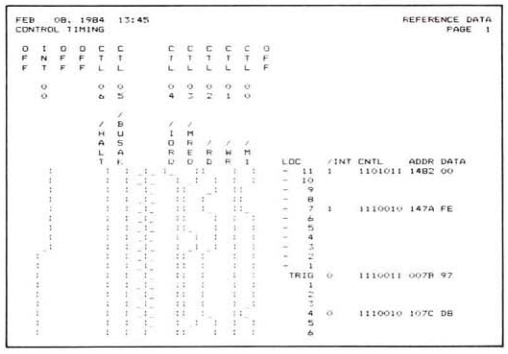



*Figure 12. Combined Format Print-out.*

The printer ROM Pack also has the ability to print a single display as it appears on the 1240. Other functions available are the search pattern, user defined timing trace labels up to 45 characters long for timing diagram printouts, and a printer test to check connections and printer operation.

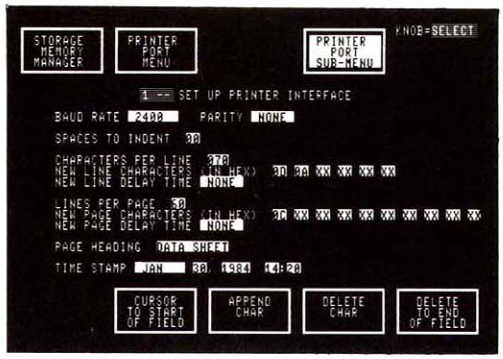
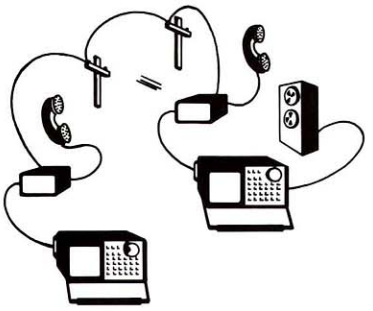



*Figure 15. Printer Port sub-menu for setting up printer interface parameters.*

## TELESERVICING

Master-Slave capability allows one 1240 to remotely control another over a telephone line. This greatly eases the higher levels of service troubleshooting, as service engineers can get to the problem via the telephone rather than having to physically travel to the problem site.



A phone link between the master 1240 and the slave 1240 can be used for sending both data and voice information. When in data mode, the master 1240 has complete control over the slave, with the ability to: send and receive set-ups, acquisition memories and reference memories, start and stop acquisitions, start and stop auto-acquisition; receive information on whether the memories were equal or not equal after auto-acquiring; initialize the slave; get the slave's status; and have the slave call the master when an acquisition or auto-acquisition is over.

In voice mode, the service engineer at the master 1240 can speak directly with the technician at the slave end and direct him to move probes or to swap boards. Switching between voice and data mode is accomplished through the master/slave menu when the Option 01 modem is used.

Also available with the Option 01 modem are auto-answer and auto-dial. With auto-answer, an unattended 1240 will respond to a call from another 1240. A master-slave connection can thus be set up without a service technician present at the slave end.

With auto-dial, a slave 1240 can be set up to automatically call the master upon triggering. If troubleshooting an intermittent problem, the slave can be set to trigger on the problem, the service technician can leave the slave site, the line can be disconnected, and when the intermittent occurs, the slave will call the master, and the service engineer can analyze the data.

The 1240 supports master/slave operation with the following configuration in each of the 1240's: a 12RC02 Master/Slave ROM Pack, a 1200C01 RS-232C COMM Pack and a modem.

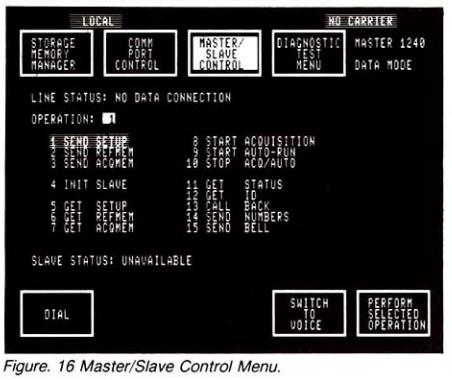



*Figure. 16 Master/Slave Control Menu.*

Each 1240 must have at least one acquisition card (1240D1 or 1240D2) installed. Once the connection between the master and a slave is established, the master will assume the card configuration of the slave until its power is turned off or until a connection is established with another slave.

The Option 01 Hayes Smartmodem 1200 is recommended for use with master/slave support in the United States, and other countries where its licensed. With this modem, the user has access to the following features through the 1240's front panel: auto-dial of up to four phone numbers, auto-answer, and soft-key switching between voice and data communication modes. This modem is not licensed in all countries, however in these countries the 12RC02 and 1200C01 can be used with many full-duplex modems. With modems other than the Hayes Smartmodem 1200, the telephone connection must be made by hand, and auto-dial, auto-answer, and soft-key switching between voice and data modes do not function.

## 1240 EXTERNAL COMMUNICATION SUPPORT

To equip the 1240 for one of the three types of communications support shown across the top of this table, choose one of the combinations of ROM Pack and COMM Pack whose intersection is indicated by XXXX's. Performance varies depending on the combination of packs that you select for a particular kind of support.

| | Remote Control | Printer Support | Master/ Slave Support |
|---|---|---|---|
| ROM Packs | None Required | 12RC01 Printer Support | 12RC02 Master/ Slave |
| COMM Packs | | | |
| 1200C01 RS-232C | XXXX | XXXX | XXXX |
| 1200C02 GPIB | XXXX | | |
| 1200C11 Parallel Printer | | XXXX | |

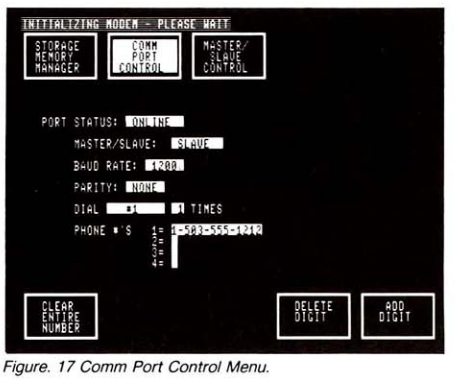



*Figure. 17 Comm Port Control Menu.*

## CHARACTERISTICS

### OPERATING LEVELS

**Level 0** — Basic Operation.
**Level 1** — Advanced timing analysis (includes basic state analysis).
**Level 2** — Advanced state analysis (includes basic timing analysis).
**Level 3** — Full operation.

### TIMEBASES

**Two Per Instrument** — Assignable by probe.
Timebase 1: Asynchronous or Synchronous.
Timebase 2: Synchronous or Demultiplex.

### INPUTS

**Clocks** — C1, C2, . . . Cn. Where n = number of probes = number of channels/9. Minimum Pulse Width: 8 ns. Specifiable as rising, falling, or either edge.
**Qualifiers** — Q1, Q2, . . . Qn. Where n = number of probes = number of channels/9. Setup Time, Hold Time: 10 ns, 0 ns. Specifiable as high or low level.
**Asynchronous** — Rate: 10 ns to 1 s (20 ns to 1 s on 1240D2). Specification: (1-2-5 sequence) • (Q1 • Q2 • . . . • Qn). Accuracy: 01%. Channel-to-Channel Skew: ±3 ns. Glitch Detection: 6 ns (on 1240D1 only).
**Synchronous** — Rate: Dc to 50 MHz. Setup Time, Hold Time: 7 ns, 1 ns (12 ns, 0 ns on 1240D2). Specification: (C1 + C2 + . . . +Cn) • (Q1 • Q2• . . . • Qn). Minimum Delay After Previous Clock: 20 ns.
**Demultiplex** — Rate: Dc to 33 MHz. Setup Time, Hold Time: 10 ns, 0 ns. Specification: First Phase Clock (Latch Data) (C1 + C2 + . . . + Cn) • (Q1 • Q2 • . . . • Qn). Minimum Delay After Last Phase Clock: 20 ns. Last Phase Clock (Store Data): (C1 + C2 + . . . + Cn) • (Q1 • Q2 • . . . • Qn). Minimum Delay After First Phase Clock: 10 ns.

### CONFIGURABILITY

Two types of acquisition cards: 1240D1, 1240D2.
Maximum of four cards per 1240, in any combination.

| | 1240D1 | 1240D2 |
|---|---|---|
| Number of Channels | 9 | 18 |
| Asynchronous Rate | 100 MHz | 50 MHz |
| With glitches | 50 MHz | N/A |
| Synchronous Rate | 50 MHz | 50 MHz |
| Memory Depth (bits/Char channel | 512 | 512 |
| With Glitches | 256 | N/A |
| Max Via Chaining | 2048 | 2048 |

**Depth vs Channels** — Tradeoffs possible between data acquisition cards of same type. Maximum depth is 2048 (with four 1240D1 or four 1240D2).

### DATA ACQUISITION

Two Types of Acquistion Probes: P6460, P6462.
One probe required per 1240D1, two per 1240D2.

| | P6460 | P6462 |
|---|---|---|
| Signal Input | | |
| Data Channels | 9 | 9 |
| Clock/ | | |
| Clock Qualifier Lines | 1 | 1 |
| Impedence | | |
| Nominal | 1 MΩ, 5 pF | ≈1 LTTL |
| Threshold Range | −6.35 V to +6.35 V | +1.4 V |
| Increments | 0.05 V | — |
| Accuracy | ±0.5% | ±.25 V |
| | ±0.065 V | +.055 V/ (0°C −25°C) |
| Threshold Assignment | By acquisition card | N/A |
| Polarity Assignment | By channel | By channel |
| Maximum Input Voltage | | |
| Peak | ±40 V | −2 to +7 V |
| Channel to Channel | ±60 V | No restriction |

NOTE: All system specifications are based upon P6460 probes, for specifications based upon P6462 probes, please refer to the 1240 Data Sheet.

### TRIGGER DEFINITION (TWO EVENT RECOGNIZERS)

**Global Event Recognizer (Event Recognizer #1)** — One level. Event Recognition specified by: Word recognizer—data (data or glitch on 1240D1). Duration filter—1 to 16 consecutive samples or 10 ns to 160 ns. Commands: Store On (Not), Trigger On (Not), Reset On (Not), Start Timer On (Not), Time While On (Not), Increment Counter On (Not), or Off. Counter/timer: Clock interval is 10 ns. Range is 0 to 99,999,999,999 (either counts or 10 ns increments) Counter/timer value may be used to cause trigger or reset.

**Sequential Event Recognizer (Event Recognizer #2)** — 14 levels. Event Recognition on each level specified by: Timebase: Which timebase to monitor for event. Word Recognizer: Data (data or glitch on 1240D1). Iteration Counter: 1 to 9999 occurances. Duration Filter: 1 to 16 consecutive samples. Selective Storage on each level specifiable: With Storage On or with Storage Off. Commands on each level: Wait For (Not), Trigger If (Not), Reset If (Not), Jump If (Not) or Delay (up to 9999). Commands at end of sequence: Trigger, Reset or Do Nothing.

**External Trigger Out** — TTL level output whenever trigger attempted.

**External Trigger In** — TTL level input can be required for enabling trigger.

### AUTORUN

**Modes of Operation** — Compare Acquisition Memory to Reference Memory: Specifiable which channels to compare, specifiable starting and ending memory locations of comparison. Result of comparison outcome: Specifiable display and reacquire, discard and reacquire, or display and stop. Specifiable minimum display time: 0 s to 99 s.

**Continuous Trigger Out** — Data is not stored. 1240 acts as trigger source.

**Trigger In** — Requires trigger in signal to enable trigger. Enables two 1240s to work in parallel.

**Store After Trigger** — Data at last trigger is available after stopping 1240. Time between storages is minimum.

### DISPLAY FORMATS

**State Table** — Acquisition or reference memory. Data displayed in binary, octal, hex, ASCII, EBCDIC. Glitch display can be turned on or off.

**Timing Diagram** — Acquisition or reference memory. Expansion factors of *1, *2, *5, *10, *20. Glitch display.

**Distance Between Cursors** — Value displayed as absolute time for unqualified asynchronous measurement, as number of memory locations for qualified or synchronous measurement.

**Highlighting Modes** — Memory comparison differences, glitches, search pattern occurences, timebase #1 occurences, timebase #2 occurrences.

**Search Pattern** — Length: 1 to 8 contiguous locations. Timebases: Can restrict each location to occur only on T1, T2 or T1 and T2.

### STORAGE

**Internal (Standard)**

**Nonvolatile Memory (NVM)** — Size: Contains two set-ups, including status at power down, lithium iodide battery.

**Volatile Memory (RAM)** — Size: Contains two set-ups.

**Memory Types**

**Set-Up** — Stored in NVM, RAM, or Pack, contains all data pertinent to making an acquisition.

**Reference Memory** — Stored in Pack, reference memory is editable in Edit Reference Memory menu.

### OTHER CHARACTERISTICS

**Diagnostics** — At power-up, the 1240 performs processor, ROM, RAM and board checks. A test pattern generator located on the side of the 1240 provides stimulus for verifying probes and acquisition system operation. Complete system verification and extended diagnostics are available with an optional ROM Pack.

**Rear Panel Connections** — Trigger In: TTL compatible. Trigger Out: TTL compatible. Video Out: Confroms with RS-170 (composite video).

**Power** — 90 V to 132 V or 180 V to 250 V. 48 Hz to 440 Hz.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 368 | 14.5 |
| Height | 197 | 7.8 |
| Depth | 498 | 19.6 |
| **Weight** | **kg** | **lb** |
| Without Accessories | 12.0 | 26.5 |

### ENVIRONMENTAL CHARACTERISTICS

**Temperature** — Operating: −10°C to +55°C. Nonoperating: −62°C to +85°C.

**Altitude** — Operating: To 4600 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft).

**Vibration** — 0.025 inch displacement. 10 Hz to 55 Hz frequency range.

**Shock** — 30 g.

### COMM PACKS

**1200C01 (RS-232C)** — Baud Rate: 110 to 9600. Bits/Character: Eight, including parity bit. Protocol: Asynchronous full duplex. Compatability: Stand-alone with host for remote control, with 12RC01 for printers with serial interface, with 12RC02 and 12RC02 Option 01 for master/slave, with 12RMXX for printers with serial interface.

**1200C02 (GPIB)** — Full listener/talker capabilities. Meets IEEE Standard 488-1978. Compatability: Stand-alone with host for remote control.

**1200C11 (Parallel Printer)** — Compatability: With 12RC01 for printers with parallel interface, with 12RMXX for printers with parallel interface.

### ROM PACKS

**Analysis**

**12R01 (Performance Analysis)** — State Overview: 1 to 11 ranges. Ranges can be different groups and different timebases. Ability to halt and resume measurement. Display in count, percentage, and histogram. Event Measurement: 1 to 11 distribution intervals. 1 to 4 events. 10 ns resolution. Five measurement types (measure total time, count cycles, count occurrences, time occurrence, accumulate time). Display in distribution, min, mean, max, and histogram.

**Communication Support**

**12RC01 (Printer Support)** — Requires: 1200C01 for serial interface or 1200C11 for parallel interface. Output: Menus, search pattern, acquisition and reference memory. Memory Format: State table, timing diagram, and combined.

**12RC02 (Master/Slave)** — Requires: 1200C01 and modem. With Option 01: auto-answer, auto-dial, voice-data switching, non-volitile storage of four phone numbers, 300 and 1200 baud. Diagnostics: local 1240 with COMM Pack and RS-232 cable, modem, and link between local and remote 1240.

**Storage**

**12RS01 (8 k RAM Pack)** — Size: Contains 8 kbytes. Lithium-iodide battery.

**12RS11, 12RS12 (32 k EPROM Pack)** — Size: Contains 32 kbytes.

**Microprocessor Support**

**12RMXX (Mnemonic Disassembly)** — Formats: State, Absolute, Hardware, Software.

### INCLUDED ACCESSORIES

Accessory pouch (016-0707-00); front panel cover (200-2780-00); operator's manual; 5 reference guides.

## ORDERING INFORMATION

**1240** Logic Analyzer Mainframe ..... **$4,500**

**Option 05** — Rackmount Adaptor ..... **+$400**

### INTERNATIONAL POWER CORDS AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

## STANDARD 1240 SYSTEM CONFIGURATIONS

**1240S08** — 8 Bit Microprocessor Analysis System (Includes 1240 Logic Analyzer with (2) 1240D2 Modules with four P6460 probes, (1) 12RS01 RAM Pack) ..... **$12,200**

**Option 01 thru 09** — Microprocessor Specific Support (Includes (1) 12RMXX Microprocessor Disassembly ROM Pack, (1) 12RMXX Option 01 Configured Probe Interface).
**Option 01** — Specific Support for 8080 ..... **+$600**
**Option 02** — Specific Support for 8085 ..... **+$600**
**Option 03** — Specific Support for 6800 ..... **+$600**
**Option 04** — Specific Support for 6802 ..... **+$600**
**Option 05** — Specific Support for 6808 ..... **+$600**
**Option 06** — Specific Support for 6809 ..... **+$600**
**Option 07** — Specific Support for Z80 ..... **+$600**
**Option 08** — Specific Support for 6502 ..... **+$600**
**Option 09** — Specific Support for NSC800 ..... **+$600**

**1240S16** — 16-Bit Microprocessor Analysis System (Includes 1240 Logic Analyzer with (3) 1240D2 Option 1D Modules without probes, (1) P6460 Probe, (1) 12RS01 RAM Pack) **$12,400**

**Option 01 thru 09** — Microprocessor Specific Support (Includes (1) 12RMXX Microprocessor Disassembly ROM Pack, (1) 12RMXX Option 02 or Option 04 Personality Module).
**Option 01** — Specific Support for 8086 ..... **+$2,500**
**Option 02** — Specific Support for 8088 ..... **+$2,500**
**Option 03** — Specific Support for 80186 ..... **+$2,500**
**Option 04** — Specific Support for 80188 ..... **+$2,500**
**Option 05** — Specific Support for 68000 (DIP) ..... **+$2,500**
**Option 06** — Specific Support for 68000 (PGA) ..... **+$2,500**
**Option 07** — Specific Support for 68008 ..... **+$2,500**
**Option 08** — Specific Support for 68010 (DIP) ..... **+$2,500**
**Option 09** — Specific Support for 68010 (PGA) ..... **+$2,500**

**1240SGP** — General Purpose Analysis System (Includes 1240 Logic Analyzer with (1) 1240D1 Module with one P6460 probe, (2) 1240D2 Modules with four P6460 probes, (1) 12RS01 RAM Pack) ..... **$15,150**

**1240SBA** — Bus Analysis System (Includes 1240 Logic Analyzer with (4) 1240D2 Modules with eight P6460 probes, (1) 12RS01 RAM Pack) ..... **$19,600**

**1240SHS** — High Speed Analysis System (Includes 1240 Logic Analyzer with (4) 1240D1 Modules with four P6460 probes, (1) 12RS01 RAM Pack) ..... **$16,600**

## OPTIONAL ACCESSORIES

### ACQUISITION CARDS

**1240D1** — 9-Channel Data Acquisition Card, 100 MHz, includes one P6460 data acquisition probe ..... **$2,950**

**Option 1D** — Deletes one P6460 Data Acquisition Probe ..... **−$700**

**1240D2** — 18-Channel Data Acquisition Card, 50 MHz, includes two P6460 data acquisition probes ..... **$3,700**

**Option 1D** — Deletes two P6460 Data Acquisition Probes ..... **−$1,400**

**Option 2S** — Substitutes two P6462 Data Acquisition for two P6460 Data Acquisition Probes ..... **−$720**

### DATA ACQUISITION PROBES

**P6460** — 9-Channel Data Acquisiton Probe ..... **$700**

**P6462** — 9-Channel Data Acquisiton Probe, fixed threshold TTL ..... **$340**

### COMMUNICATION INTERFACES (COMM PACKS)

**1200C01** — RS-232C COMM Pack ..... **$750**

**1200C02** — GPIB COMM Pack ..... **$850**

**1200C11** — Parallel Printer COMM Pack ..... **$500**

Note: To order cables for these COMM Packs, see the Logic Analyzer's Accessories Section.

### ROM PACKS

**Analysis**

**12R01** — Performance Analysis ROM Pack ..... **$800**

**Communication Functions**

**12RC01** — Printer Support ROM Pack ..... **$300**

**12RC02** — Master/Slave ROM Pack ..... **$500**

**Option 01** — Modem ..... **+$600**

**Storage**

**12RS01** — 8 k RAM Pack ..... **$300**

**12RS11** — 32K EPROM PACK (Empty) ..... **$85**

**12RS12** — 32K EPROM PACK ..... **$300**

### SERVICE ACCESSORIES

**12RD01** — Diagnostic ROM Pack ..... **$1,500**

**Diagnostic Lead Set** — Order 012-0556-00 ..... **$50**

**Extender Card** — Order 670-7539-02 ..... **$400**

**Service Manual**

**Service Maintenance Kit** — Includes the above service accessories. Order 067-1103-02 ..... **$2,000**

### CARTS

**Portable Instrument Cart** — For on site portability. Order K212. See page 429 for complete description ..... **$330**

**Instrument Shuttle** — For site-to-site portability. Order K117. See page 429 for complete description ..... **$265**

**Microprocessor and Bus Support**

**Standard Modules for Many Microprocessors**

**Single-Plug Connection for Ease of Use and Reliability**

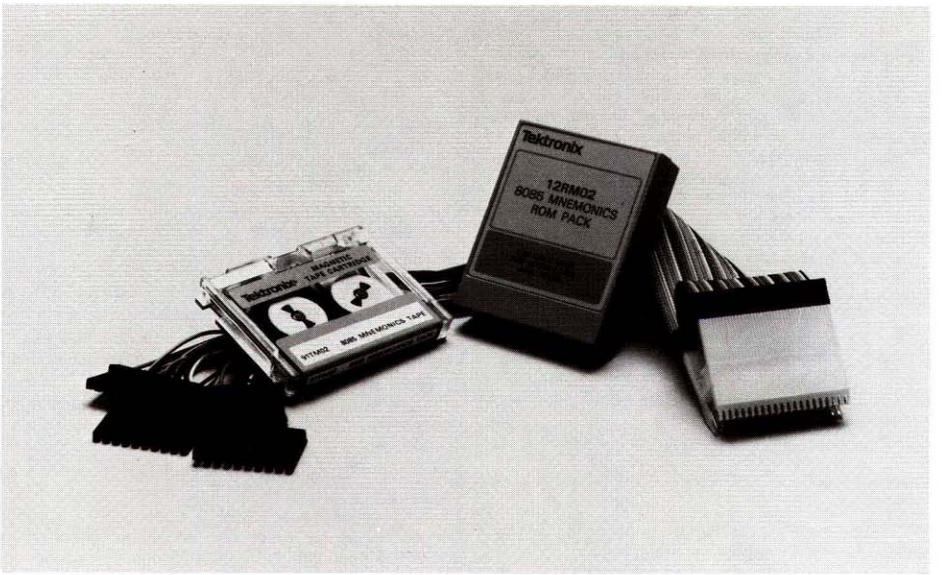
**Ready-to-Use Mnemonics on Tape or ROM Pack**

**PM200 Personality Modules for Advanced Microprocessors**

Tektronix logic analyzers offer wide-ranging microprocessor support with a selection of single-plug connectors and mnemonic disassembly packages.

For custom microprocessors, or microprocessors not listed below, Tektronix offers support through EDM (Extended Define Mnemonics) on the DAS 9100, which is described on page 108. Also, the Universal Probe Interface Kit (UPIK40) on page 132 is a general-purpose, single-plug connection.

In addition to microprocessors, Tektronix offers support for several popular bus implementations, including the UNIBUS, the Q-BUS, and the GPIB (IEEE Standard 488), and the ASCII and EBCDIC character codes.




*The Option 01 probe interface works with the mnemonics files on tape or ROM pack to support disassembly on the DAS 9100 and the 1240.*

Table A contains information about the microprocessor support available for the 1240. Table B describes the microprocessor support on the DAS 9100, using 91A24 Data Acquisition Modules. Table C covers bus support on the DAS 9100, again using 91A24 modules.

**TABLE A**
**ORDERING AND CONFIGURATION GUIDE FOR 1200 SERIES MICROPROCESSOR SUPPORT**

| Microprocessor | For Mnemonics ROM Pack Order | For Probe Interface Order | For PM200 Support Order | Total No. 1240D2's Required | Total No. Probes[1] Required | Processor Clock Rate Supported |
|---|---|---|---|---|---|---|
| 8080 | 12RM01 | Opt 01 | | 2 | 4 | Max |
| 8085 | 12RM02 | Opt 01 | | 2 | 4 | Max |
| 8086 (DIP) | 12RM03 | | Opt 02 | 3 | None | 8 MHz |
| 8088 (DIP) | 12RM04 | | Opt 02 | 3 | None | 8 MHz |
| 80186 (LCC) | 12RM05 | | Opt 02 | 3 | None | 8 MHz |
| 80188 (LCC) | 12RM06 | | Opt 02 | 3 | None | 8 MHz |
| 6800 | 12RM21 | Opt 01 | | 2 | 4 | Max |
| 6802 | 12RM22 | Opt 01 | | 2 | 4 | Max |
| 6808 | 12RM23 | Opt 01 | | 2 | 4 | Max |
| 6809 | 12RM24 | Opt 01 | | 2 | 4 | Max |
| 68000 (DIP) | 12RM25 | | Opt 02 | 3 | None | 12.5 MHz |
| 68000 (PGA) | 12RM25 | | Opt 04 | 3 | None | 12.5 MHz |
| 68008 (DIP) | 12RM26 | | Opt 02 | 3 | None | 8 MHz |
| 68010 (DIP) | 12RM27 | | Opt 02 | 3 | None | 12.5 MHz |
| 68010 (PGA) | 12RM27 | | Opt 04 | 3 | None | 12.5 MHz |
| Z80 | 12RM41 | Opt 01 | | 2 | 4 † | Max |
| Z8001/Z8003 | 12RM42 | | | 3 | 4 | Max |
| Z8002/Z8004 | 12RM43 | Opt 01 | | 3 | 3 | Max |
| 6502/65C02 | 12RM63 | Opt 01 | | 2 | 4 * | Max |
| F9450 (1750A MIL STD) | 12RM62A | | | 3 | 3 | Max |
| NSC800 | 12RM71 | Opt 01 | | 2 | 4 † | Max |

*[1] For most of the above processors, either P6460 or P6462 Data Acquisition probes can be used. *For those marked with a "*", P6460's are required if you're using a CMOS version of the processor. †For those marked with a "†", P6460's are always required.*

**ORDERING INFORMATION**

**For all items in Table A, prices are as follows:**

**12RMXX** Mnemonics ROM Pack ..... **$400**
**Option 01** — Probe Interface ..... **+$200**
**Option 02** — PM200 Support ..... **+$2,100**

# DAS 9100 MICROPROCESSOR SUPPORT

Microprocessor disassembly requires a 91TM mnemonics tape along with 91A24/91AE24 Acquisition modules. An easy-to-use single-plug probe adaptor (Option 01) is available for most 8-bit processors. Intel and Motorola 16-bit processors require PM200 Series Personality Modules (Options 02 or 04). The PM200s provide fetch indication, queue tracking and clock synthesis in addition to single-plug connection and built-in acquisition probes: 91A24/91AE24 modules are available without probes for dedicated PM200 use. Order one each 91A24 and 91AE24 for microprocessor support (except 8039 which needs just 91A24 only). Note that DAS 9100 Option 01 (DC 100 Tape Drive) is required to use these microprocessor support packages.

**TABLE B: ORDERING AND CONFIGURATION GUIDE FOR DAS 9100 SERIES MICROPROCESSOR SUPPORT**

| | REQUIRED | OPTIONAL | REQUIRED | | |
|---|---|---|---|---|---|
| **Microprocessor** | **For Disassembly Tape Order** | **For Probe Interface Order** | **For PM 200 Module Order** | **Total No Probes[1] Required** | **Processor Clock Rate Supported** |
| 8080 | 91TM01 | Opt 01 | N/A | 4 | Max |
| 8031 | 91TM07 | Opt 01 | N/A | 4 † | Max |
| 8039 | 91TM10 | Opt 01 | N/A | 3 † | Max |
| 8085 | 91TM02 | Opt 01 | N/A | 4 | Max |
| 8086 (DIP) | 91TM03 | N/A | Opt 02 | None | 10 MHz |
| 8088 (DIP) | 91TM04 | N/A | Opt 02 | None | 10 MHz |
| 80186 (LCC) | 91TM05 | N/A | Opt 02 | None | 10 MHz |
| 80188 (LCC) | 91TM06 | N/A | Opt 02 | None | 10 MHz |
| 6800 | 91TM21 | Opt 01 | N/A | 4 | Max |
| 6801 | 91TM28 | Opt 01 | N/A | 4 | Max |
| 6802 | 91TM22 | Opt 01 | N/A | 4 | Max |
| 6803 | 91TM29 | Opt 01 | N/A | 4 | Max |
| 6805[2] | 91TM30 | UPIK40 | N/A | 4 * | Max |
| 6808 | 91TM23 | Opt 01 | N/A | 4 | Max |
| 6809 | 91TM24 | Opt 01 | N/A | 4 | Max |
| 68121 | 91TM32 | N/A | N/A | 4 | Max |
| 68000 (DIP) | 91TM25 | N/A | Opt 02 | None | 12.5 MHz |
| 68000 (PGA) | 91TM25 | N/A | Opt 04 | None | 12.5 MHz |
| 68008 (DIP) | 91TM26 | N/A | Opt 02 | None | 8 MHz |
| 68010 (DIP) | 91TM27 | N/A | Opt 02 | None | 12.5 MHz |
| 68010 (PGA) | 91TM27 | N/A | Opt 04 | None | 12.5 MHz |
| Z80 | 91TM41 | Opt 01 | N/A | 4 † | Max |
| Z8001/03 | 91TM42 | N/A | N/A | 4 | Max |
| Z8002/04 | 91TM43 | Opt 01 | N/A | 3 | Max |
| 6502/65C02 | 91TM63 | Opt 01 | N/A | 4 * | Max |
| 1802 | 91TM61 | Opt 01 | N/A | 4 * | Max |
| 1805 | 91TM65 | Opt 01 | N/A | 4 * | Max |
| F9450 | 91TM62 | N/A | N/A | 3 | Max |
| 1750A | 91TM64 | N/A | N/A | N/A | N/A |
| NSC 800 | 91TM71 | Opt 01 | N/A | 4 † | Max |

*[1] For most of the above processors, either P6460 or P6462 data acquisition probes can be used. *For those marked with a "*", P6460's are required if you're using a CMOS version of the processor. †For those marked with a "†", P6460's are always required. [2] Supports the 146805E2.*

## ORDERING INFORMATION

**For all items in Table B, prices are as follows:**

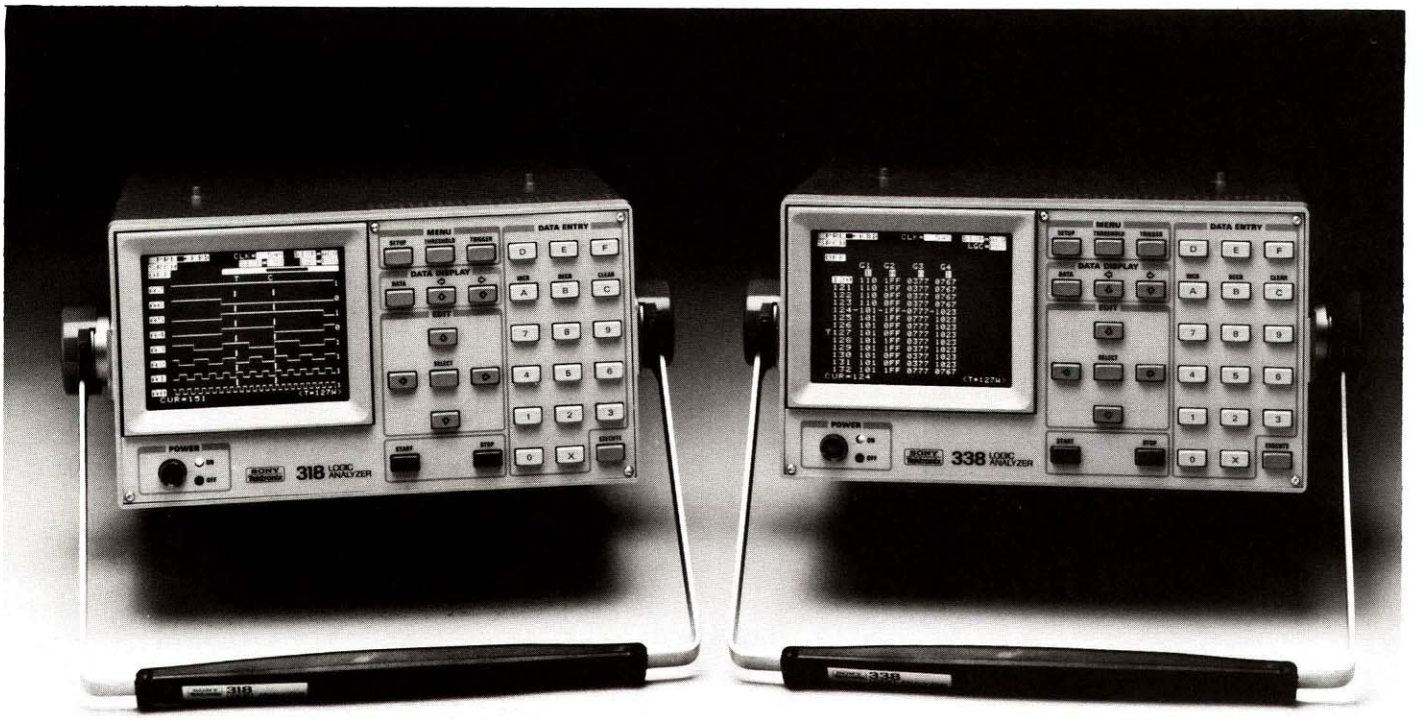
**91TMXX** Mnemonics Tape ..... **$350**
**Option 01** Probe Interface ..... +$200

**Option 02** PM 200 Support ..... +$2,100
**Option 04** PM 200 Support ..... +$2,100
**UPIK40** ..... +$175

**91TM51 or 91TM52** Mnemonics Tape ... **$350**
**91TM53** Mnemonics Tape ..... **$200**
**91TM53** Option 01 Probe Adaptor ..... **+$180**

**TABLE C: ORDERING AND CONFIGURATION GUIDE FOR DAS 9100 SERIES BUS SUPPORT**

| **Bus/Code** | **For Mnemonics Tape Order** | **For Probe Interface Order** | **Total No. 91A24 & 91AE24's Required** | **Total No. Probes Required** | **Bus Clock Rate Supported** |
|---|---|---|---|---|---|
| UNIBUS | 91TM51 | | 2 | 4 | Max |
| Q-BUS | 91TM52 | | 2 | 4 | Max |
| GPIB/ASCII/EBCDIC | 91TM53 | Opt 01 | 1 | 3 | Max |






## 318/338 Logic Analyzers

**Superior Performance/Price Ratio**

**Parallel and Serial Data Acquisition in a Single Instrument**

**Data Widths to 32 Channels and Acquisition Speeds to 50 MHz**

**Menu-Driven User Interface for Easy Operation**

**Powerful Multilevel Triggering**

**Separate Glitch Trigger and Memory**

**RS-232 Interface Allows Remote Control**

**Nonvolatile Memory Retains Both Reference Data and Instrument Setups**

**Ultra-Lightweight for Maximum Portability Weighs Only 5.2 kg (11.5 lbs)**

The Sony/Tek 318 and 338 Logic Analyzers bring an unprecedented combination of performance, portability and low price to the field of digital test instrumentation.

Weighing only 5.2 kg (11.5 lb) each, these instruments incorporate proprietary LSI circuitry to provide an array of features usually associated with much larger logic analyzers. Both the 318 and 338 include parallel and serial data acquisition capabilities to cover the widest possible range of applications. For software work, there is powerful multilevel triggering to capture complex real-time code execution. Each instrument can also be remotely controlled through an RS-232 interface, an extremely useful feature in first-line service applications. Also, nonvolatile memory allows both setup information and reference data to be retained and transported from site to site.

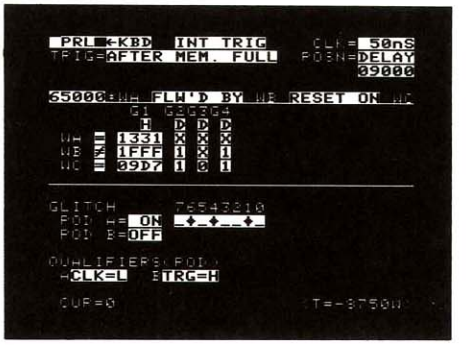
The 318 and 338 Logic Analyzers are both built around the same basic feature set. The difference between the two instruments is in maximum data width and acquisition speed. The 338, which is targeted more toward software applications, allows 32 channels of data acquisition at speeds up to 20 MHz. The 318, which is directed toward hardware applications, permits 16 channels of data acquisition at speeds up to 50 MHz.

Aside from these width/speed differences, the 318 and 338 pack the same powerful features into a highly portable instrument. The basic 318/338 includes parallel state and timing acquisition, with acquisition, reference and glitch memories.

The S1 configuration adds serial acquisition, an RS-232 remote control interface, and nonvolatile memory.

### Parallel State Acquisition

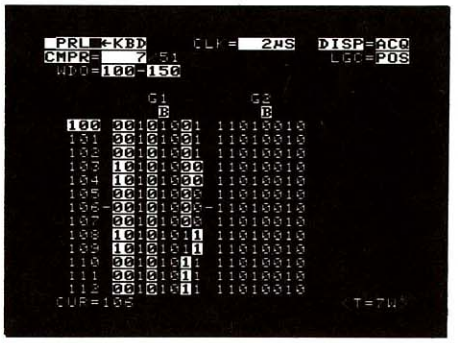
For either software or timing applications, the 318/338 contains a powerful 3-level trigger which allows the capture of complex event sequences as executed by the hardware under test.




*A 3-level trigger lets you define up to three events (A,B,C) which are then combined by using various operators to form the trigger sequence.*

This trigger allows definition of three separate logic events which can be combined through a series of operators to specify the actual trigger sequence. Up to 65,000 occurrences can be required for the first event to come true. The next two events can follow immediately (THEN) or later (FOLLOWED BY). Two or three events can be ORed together. The third event can also be used to reset the trigger sequence.

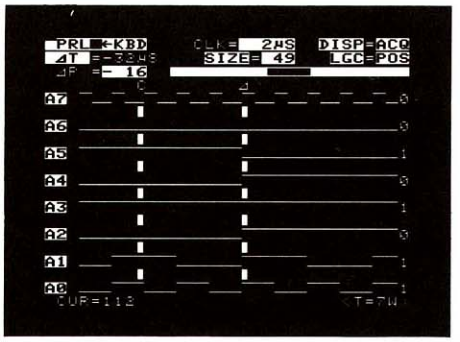
Once acquired, parallel state information can be displayed in binary, hex, octal or decimal radix. The data can be searched for each occurrence of a specified word, and can also be compared with data stored in the reference memory, with any differences highlighted on the display.




*You can compare the data you have just acquired to a set of data in reference memory. All differences are displayed in reverse video.*

### Parallel Timing Acquisition

For timing applications data can be acquired either synchronously, using the clock of the system under test, or asynchronously, using the 318/338's own internal clock. Up to eight channels of timing data can be displayed at once, and each can be identified through a 2-character label entered by the user. For increased accuracy, there is a "delta" measurement feature which counts and displays the number of sample intervals between two movable cursors. For data acquired asynchronously, the time difference is shown on the screen.




*Timing displays include analysis tools such as measurements between cursors, variable grouping, memory search and glitch display.*

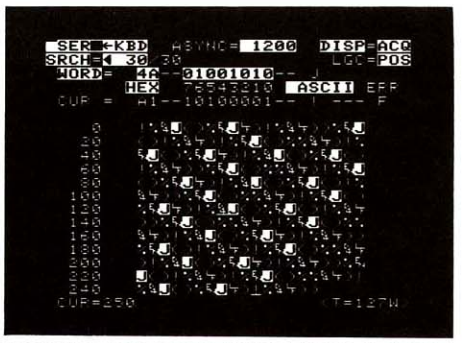
There is also full glitch capture capability. Glitch information is automatically acquired and separately stored any time parallel data is acquired. A separate glitch trigger allows glitch occurrences to be specified on a channel-by-channel basis, with each channel of the glitch trigger ORed with its counter-part in the main trigger.

### Serial Data Acquisition

A major part of the S1 configuration package is serial data acquisition, which adds considerable breadth to the instruments' application range. Serial acquisition can take place in either synchronous or asynchronous modes at up to 19200 bits/second, with either 5, 6, 7, 8 or 9 bits per character. For synchronous acquisition, the user can specify sync and hunt words as well as trigger words.

*When defining a serial data acquisition trigger, you can specify sync and hunt words as well as trigger words.*

Acquired serial data can be displayed in either state table or character formats. The state table format gives a wide range of radices, including hex, binary, ocatal, ASCII and EBCDIC. The character format provides 256-character stream displays in either ASCII or EBCDIC. In addition, acquired serial data may be searched for occurrences of a specific word and compared with data stored in reference memory.




*Captured serial data can be displayed in state or character format. Data can also be searched for occurrences of a specified word.*

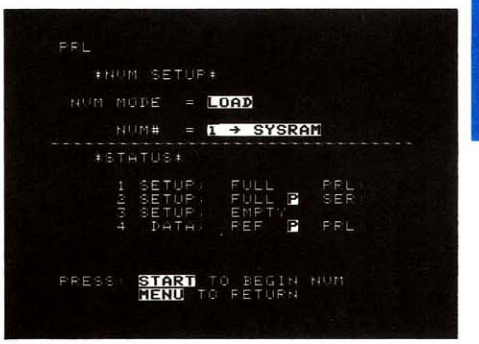
### RS-232 Interface for Remote Control

The S1 configuration package includes an RS-232 interface. This allows complete control of the instrument by a remote processor or terminal which can be connected through either a modem or local lines. Consequently, a remote operator can define triggers, acquire data and analyze the results. In addition, the operator can input a reference pattern via a remote terminal. All aspects of the remote connection, such as baud rate, local/remote echo and bits/character, are easily set up through menu prompts supplied by the 318/338.

*Setting up the RS-232 interface is simplified by easy to use menu prompts.*

### Nonvolatile Memory

Also included in the S1 configuration is a nonvolatile memory for storage of instrument setups and data. This memory holds up to three setups (channel configurations, trigger values, and thresholds) and one set of memory data.




*3 Setups and 1 memory (acquisition or reference) can be stored and protected in the nonvolatile memory.*

The nonvolatile memory is useful for rapid restoration of setups and reference data under many conditions. It is especially helpful when using the instrument at a remote service location, where a less skilled technician can quickly configure the instrument to a stored setup with minimal operator intervention.

### PARALLEL ANALYZER FUNCTION

#### DATA INPUT

**Channels** — 318: 16 channels; glitch data is detected on all 16 channels.

338: 32 channels; glitch data is detected on 8 channels (POD A).

**Minimum Logic Swing** — 500 mV p-p; centered on threshold voltage.

**Maximum Logic Swing** — Threshold voltage plus 10 V to threshold voltage minus 15 V.

**Glitch Data Width** — 5 ns minimum with 350 mV overdrive from threshold.

**Threshold Voltage** — TTL: +1.4 V.
V 1: −10 V to +10 V.
V 2: −10 V to +10 V.
V 3: = (V 1 +V 2)/2.

#### SAMPLING

| External Clock Mode | 318 | 338 |
|---|---|---|
| Data setup time | 13 ns max | 14 ns max |
| Data hold time | 0 ns max | 0 ns max |
| Clock period | 20 ns min | 50 ns min |

**Clock Pulse Width** — High-Logic level: 15 ns min. Low-Logic Level: 15 ns.

**Clock Polarity** — + or −edge.

#### INTERNAL CLOCK MODE

**Sample Interval**
318: 20 ns to 500 ms/sample in 1-2-5 sequence.
338: 50 ns to 500 ms/sample in 1-2-5 sequence.

| Data Memory Depth | 318 | 338 |
|---|---|---|
| Acquisition Memory | 16 x 256 bits | 32 x 256 bits |
| Reference Memory | 16 x 256 bits | 32 x 256 bits |
| Glitch Memory | 16 x 256 bits | 8 x 256 bits |

#### TRIGGERING

**Internal Trigger**
**Word Recognizer** — Three words: A, B, and C; selected channels are AND'd together.

**Input** — All data input channels from P6451 data acquisition probes.

**Glitch Trigger** — Selected channels are OR'ed together.

**Trigger Position** — Begin, Center, End, Delay up to 65,000 clock cycles.

**External Trigger**
**Input** — Mini-jack connector on side panel, TTL compatible.

**Threshold** — 1.4 V nominal (TTL level).

**Polarity** — + or −edge.

**Pulse Width** — 20 ns minimum.

**Trigger Output** — Initiated high when an internal trigger sequence, glitch trigger or external trigger is detected. Reset on next acquisition start.

**Output Level** — TTL.

**Current Max** — High-Logic Level: 1 mA.
Low-Logic Level: 2 mA.

#### DATA DISPLAY

**Timing Diagram Mode** — Maximum of eight channels (one page) present on screen at one time. The 318 has two pages; the 338 has four pages.

Glitch Display: Displays glitches on timing diagram as a bit width transition edge.

Search: Searches for glitches or user defined word.

**ΔT** — Movable cursor for calculating the number of clocks and temporal distance between two events.

**State Table Mode** — Hex, decimal, octal, or binary radix format.

Search: Searches for glitches or user defined word.

Compare: Compares acquisition memory to reference memory and displays mismatched characters in reverse video.

### SERIAL STATE ANALYZER FUNCTION

#### DATA INPUT

**Data Timing** — Synchronous or asynchronous.

**Bits/Character** — 5, 6, 7, 8 or 9 bits (includes parity bit if parity is active).

#### SAMPLING

**Internal Clock for Asynchronous Mode** — 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 9600, and 19,200 bits/second.

**External Clock for Both Synchronous and Asynchronous Modes** — Up to 19,200 bits/second.

**Parity Control** — Odd, even, or none.

#### TRIGGER SOURCE

Internal or external.

#### DATA DISPLAY

**State Table Mode** — Hex, binary, octal, ASCII, EBCDIC radix.

Search: Searches for parity errors or user defined word.

Compare: Compares acquisition memory to reference memory and displays mismatched characters in reverse video.

**Character Table Mode** — All 256 bits of memory displayed in either ASCII or EBCDIC radix.

Search: Searches for parity errors or user defined word.

Compare: Compares acquisition memory to reference memory and displays mismatched characters in reverse video.

### RS-232 INTERFACE

**Data Transmission Type** — Asynchronous only.

**Communication Mode** — Full Duplex.

**Bits/Character** — Eight bits with parity.

**Parity** — Even.

**Data Transfer Rate** — 110, 150, 300, 600, 1200, 2400, 4800, 9600 BPS.

**Signal Characteristics** — Meets RS-232C standard.

**I/O Connector** — 25 pin standard connector.

### NONVOLATILE MEMORY

**Memory Size** — Three setups (serial or parallel) and one memory acquisition or reference.

**Nonvolatile Period** — Approximately five years at room temperature.

### POWER REQUIREMENTS

**Line Voltage Range** — 90 V to 132 V ac, 180 V to 250 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width with handle | 237 | 9.3 |
| Height with accessory pouch | 174 | 6.8 |
| Height without accessory pouch | 120 | 4.7 |
| Depth, handle not extended | 409 | 16.1 |
| Depth, handle extended | 492 | 19.4 |
| **Weight** | **kg** | **lb** |
| Net without accessories | 5.1 | 11.5 |
| 318S1 with accessories | 6.7 | 14.7 |
| 338S1 with accessories | 7.2 | 15.7 |

### INCLUDED ACCESSORIES

Power cord (161-0104-00); accessory pouch (016-0697-00); P6107 Probe (1 additional with the S1 configuration) (010-6107-03); P6451 probe, two with the 318, four with the 338 (010-6451-07); workbook, reference guide, operator's manual.

## ORDERING INFORMATION

**318** Logic Analyzer ..... **$5,300**

**318S1** Logic Analyzer with Serial Analysis, RS-232 and Nonvolatile Memory ..... **$6,500**

**318F1** Field Installed Serial Analysis, RS-232 and Nonvolatile Memory ..... **$1,500**

**338** Logic Analyzer ..... **$5,800**

**338S1** Logic Analyzer with Serial Analysis, RS-232 and Nonvolatile Memory ..... **$7,000**

**338F1** Field Installed Serial Analysis, RS-232 and Nonvolatile Memory ..... **$1,500**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

### OPTIONAL ACCESSORIES

**Service Manual**

**RS-232 Cable** — Order 012-0757-00 ..... **$140**

**Service Maintenance Kit** — Order 067-1159-01 ..... **$625**

**Null Modem Cable** — Order 012-0530-00 ..... **$75**

The SONY®/TEKTRONIX® 300 Series is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo Japan, Outside of Japan the 300 Series is available from Tektronix, Inc., its marketing subsidiaries and distributors.

### 300 SERIES COMPARISON CHART

| Characteristics | 308 | 318 | 318S1 | 338 | 338S1 |
|---|---|---|---|---|---|
| No. Parallel Data Channels | 8 | 16 | 16 | 32 | 32 |
| Maximum Asynchronous Sample Rate | 20 MHz | 50 MHz | 50 MHz | 20 MHz | 20 MHz |
| Maximum Synchronous Sample Rate | 20 MHz | 50 MHz | 50 MHz | 20 MHz | 20 MHz |
| No Trigger Levels | 1 | 3 | 3 | 3 | 3 |
| Acquisition Memory Depth (Bits/Channel) | 252 | 256 | 256 | 256 | 256 |
| Reference Memory Depth (Bits/Channel) | 252 | 256 | 256 | 256 | 256 |
| Glitch Latch (Channels) | 8 | | | | |
| Glitch Capture (Channels) | No | 16 | 16 | 8 | 8 |
| Glitch Trigger (Channels) | No | 16 | 16 | 8 | 8 |
| Signature Analysis | Yes | No | No | No | No |
| Serial Data Acquisition | Yes | No | Yes | No | Yes |
| RS-232 Remote Control Interface | No | No | Yes | No | Yes |
| Nonvolatile Memory | No | No | Yes | No | Yes |
| Video Output | No | Yes | Yes | Yes | Yes |
| Weight (without accessories) | 8 lb | 11.5 lb | 11.5 lb | 11.5 lb | 11.5 lb |
| Price | $3,950 | $5,300 | $6,500 | $5,800 | $7,000 |

# 308

**Four Analyzers in One**

**Up to 25 Channels of Word Recognition Triggering**

**Ultra-Portable**

**Easy to Use**

**Cost Effective**

The 308 is a 20 MHz portable analyzer containing a unique combination of features. It provides timing, state, serial, and signature analysis in an extremely easy-to-use package.

## CHARACTERISTICS

### SIGNAL INPUTS

**Timing and State** — Multi-line probe-tip, eight data lines, one clock and one ground lead.

Maximum Number of Inputs: Eight.

Input Impedance: 1 MΩ, 5 pF.

**Logic Swing** —

Minimum: 500 mV +2% of threshold voltage, p-p, centered on threshold voltage.

Maximum: Threshold +10 V to Threshold −15 V.

Maximum Nondestruct Input Voltage: ±40 V.

Width of Data Input: 10 ns minimum with 400 mV overdrive from threshold voltage.

**Threshold Voltage** — TTL: +1.4 V ±0.2 V.
Variable: −12 V to +12 V.

Input Mode: Selectable sample or latch (to 5 ns with 550 mV overdrive voltage).

**Serial** —
Single Channel Probe Input: 10 MΩ, 13 pF input impedance. 500 V maximum nondestructive input voltage at probe tip. 250 V peak at BNC input connector.

Logic Swing: 500 mV minimum + 2% of threshold voltage, p-p, centered about the threshold. ±30 V maximum.

Selectable Parity: ODD, EVEN or NONE.

Selectable Bits Per Character: 5, 6, 7 or 8 bits (includes parity if active).

Selectable Input Logic: Positive or negative (at probe tip).

Synchronizing Word (Synchronous Mode Only): Programmable to require two equal words. If not programmed, defaults to ASCII word SYN.

Hunt Word (Synchronous Mode Only): Programmable to require one word. If not programmed, defaults to "XXXXXXXX" (not defined).

Stop Bits (Asynchronous Mode Only): Responds to one or more bits.

**Signature Analyzer** — Single Channel Data Input Via Probe: 10 MΩ, 13 pF clock start and stop inputs provided by data acquisition probe.

### CLOCK

**Timing and State** —

External Clock: 50 ns minimum period. 24.5 ns high-logic level minimum pulse width. 24.5 ns low-logic level minimum pulse width. 25 ns minimum data setup time. 0 ns minimum data hold time.

Internal Clock: 20 MHz sample interval (50 ns minimum). Data pulse width of one sample interval +10 ns required to insure sampling minimum. Sample intervals of 50 ns to 200 ms/sample in 1, 2, 5 sequence.

Qualifier Input: Selectable trigger or clock.
+1.4 V ±0.2 V TTL input threshold.
−5 V to +10 V maximum input voltage.

**Serial** —
Synchronous or Asynchronous.

Internal Clock for Asynchronous Mode Selectable Via Keyboard: 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, and 9600 bits/second (baud rate).

Internal Clock Accuracy: ±0.02%.

External Clock for Asynchronous Mode: Up to 9600 baud.

External Clock for Synchronous Mode: Up to 9600 baud.

### MEMORY

**Data Acquisition Memory** — 8 x 252 bits.

**Reference Memory** — 8 x 252 bits.

**Triggering (State and Timing)** —
Synchronous or asynchronous.
External qualifier.
Data Word Recognizer: Eight channels, programmable in hex, binary, octal, or decimal.

External Word Recognizer Probe: 16 channels, programmable in hex, binary, octal, or decimal.

Input Threshold: +1.4 V ±0.2 V TTL.

Word Recognizer Out: +1.4 V ±0.2 V TTL.

Trigger Delay: Programmable from 0 to 65,535 clock cycles.

Data Position: Pre- or post-trigger selectable.

First trigger mode (internal select).

**Triggering (Serial)** —

Data Word Recognizer: Programmable to require a sequence of two words (or characters).

External Trigger: Programmable for one bit (0 or 1).

Trigger Delay: Programmable from 0 to 65,535 by word count (character).

Data Position: Pre- or post-trigger selectable.

Framing Error Detection: Data acquisition is stopped when a valid stop bit is not detected.

### DISPLAY

Status information of the 308 is always displayed at the top of the screen. The menu is displayed will all fields visible. In serial mode, an extended menu is provided for additional serial capabilities.

**Timing Diagram** — Programmable memory window size. Cursor position pointer and word decode. Positive or negative logic display.

**State Table** — Simultaneous display of hex, binary, and octal. 12 word display table.

Search Mode: Inverse video highlighting.

Compare Mode: Inverse video highlighting of differences.

Positive or negative logic display.

**Serial** —
Simultaneous display of hex, binary, and ASCII. 12 word character display.

Search Mode: Inverse video display of word.

Compare Mode: Inverse video display of differences.

Positive or negative logic display.

**Signature** —
Displays the selects for clock, start, and stop. Displays each signature simultaneously. Displays a four digit signature.

Displays Character: 0 to 9, A, C, F, H, P, U.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 237 | 9.3 |
| Height | 117 | 4.6 |
| Depth | 359 | 13.9 |
| **Weight** | **kg** | **lb** |
| Net without probes | 3.7 | 8.0 |
| Net with probes | 4.5 | 10.0 |

### POWER REQUIREMENTS

**Line Voltage** — 90 V to 132 V ac, 180 V to 250 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Power** — 40 W maximum.

**Temperature Range** — 0°C to +50°C, operating.

### INCLUDED ACCESSORIES

Power cord (161-0104-00); accessory pouch (010-0654-00); P6451 probe (016-6451-05); P6107 probe (010-6107-03); operator's manual, maintenance manual.

### ORDERING INFORMATION

**308** Data Analyzer ..... **$3,950**

**Option 01** — P6406 Word Recognizer Probe ..... **+$420**

**Option 03** — Extended Signature Analysis Capability (Includes P6406 Word Recognizer Probe) ..... **+$1,950**

**1105** Battery Power Supply ..... **$1,550**

**Option 01** — 230 V Operation ..... **NC**

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

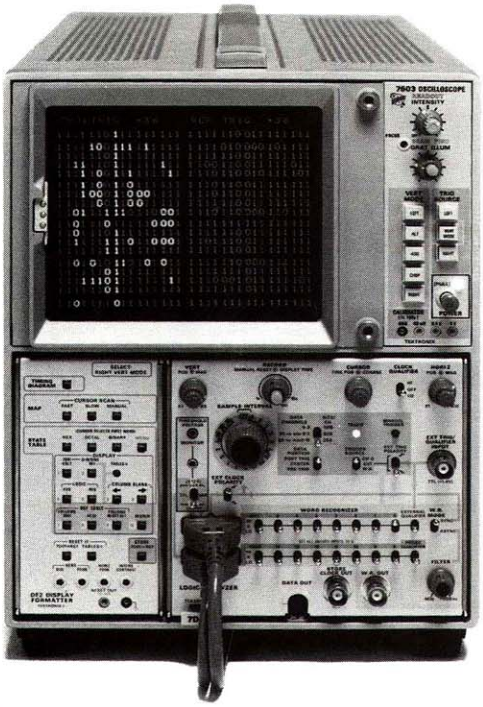
**Option A2** — UK, 240 V/13 A, 50 Hz

**Option A3** — Australian, 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

**Option A5** — Switzerland 220 V/10 A, 50 Hz

The Sony®/Tektronix® 300 Series is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 300 Series is available from Tektronix, Inc., its marketing subsidiaries and distributors.



## 7D01 General Purpose Logic Analyzer

**16 Stored Channels**

**Up to 1024 Words Deep**

**State or Timing Display of All Data**

**Up to 100 MHz Sample Rate**

**High Impedance Probes**

**18-Bit Word Recognizer**

**Clock Qualifier**

The 7D01 is a dual-wide plug-in instrument that occupies one vertical amplifier compartment and an adjacent time base compartment in 7000 Series oscilloscope mainframes. With this compatibility, you can configure a logic analysis system. Using a four-wide mainframe oscilloscope, you can combine your logic analyzer with your analog oscilloscope and display the outputs of both at the same time.

## Display Formatters

There are two display formatters available with the 7D01 Logic Analyzer—the DF1 and DF2. Both offer timing, mapping, and state table displays in binary, hexadecimal, and octal formats. The DF2 offers additional formats for IEEE Standard 488/GPIB and ASCII.

The display formatters are dedicated for use with the 7D01. They provide complete alphanumeric character generation, so that the logic analysis package can be used in mainframes without CRT readout (mainframe Option 01).

There are also two modes of automatic data acquisition in the DF1 and DF2 that compare the entire 7D01 memory to the reference memory. If a difference is detected, the difference and location will be intensified in the display readout at the top of the CRT, and the number of resets required to find the error will be displayed. This function, called RESET IF 7D01 = REF, allows full comparison of stored and newly acquired data. To compare only the tables selected by the cursor control, use RESET IF TABLES = .

### 7D01 CHARACTERISTICS

The 7D01 acquires 4, 8, or 16 channels of data and stores the data in a 4k memory. Data storage format is selectable as 4 channel X 1016 bits, 8 channels X 508 bits, or 16 channels X 254 bits.

Data sampling can be asynchronous (internal clock) or synchronous (external clock). In asynchronous modes, sampling rates can be selected up to 100 MHz in the 4 channel mode, up to 50 MHz in the 8 channel mode, or up to 20 MHz in the 16 channel mode. External sampling clocks up to 50 MHz can be used in the 4 and 8 channel modes, and up to 25 MHz in the 16 channel mode.

#### SIGNAL INPUTS

**Clock, Qualifier, and Data Input Source** — Two multilead P6451 Probes provide connections for 9 channel (9 input and ground) each. Channel 0-7 and clock are through probe 1, and channel 8-15 and qualifier are through probe 2. Each probe attaches through a 25-pin connector at the 7D01 front panel.

**Input Impedance** — 1 MΩ paralleled by 5 pF (at probe head).

**Threshold at Probe Tips** — Front panel switch selects fixed TTL (+1.4 V ±0.2 V), variable (±12 V) or split (variable for top probe, TTL for bottom probe). Front panel jack monitors variable threshold only.

**Minimum Logic Swing** — 500 mV plus 2% of threshold voltage p-p or less, centered on the threshold voltage.

**Maximum Logic Swing** — −40 V or less, to at least threshold voltage plus 10 V. (Maximum nondestructive input ±40 V.)

#### ENVIRONMENTAL

**Temperature** — Operating: 0°C to +40°C. Nonoperating: −40°C to +75°C.

**Altitude** — Operating: To 4600 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft).

**Vibration** — With the 7D01 and DF1 or DF2 combined, frequency swept from 10 to 50 cps at one minute per sweep. Vibrate for 15 minutes along each of the 3 major axes at 0.015 inch total displacement. Hold three minutes at any major resonance, or if none, at 50 cps. Total time, 54 minutes.

**Shock** — Operating and nonoperating: 30 g's, 3½ sine 11 s duration, two shocks in each direction along three major axes, for a total of 12 shocks.

#### AC POWER

**Line Voltage Ranges** — Determined by the 7000 Series oscilloscope mainframe.

**Power Consumption** — 32 W at nominal line voltage.

#### INCLUDED ACCESSORIES

Two P6451 Data Input Probes (010-6451-03); manual.

### DF1 CHARACTERISTICS

The DF1 reformats the output of the 7D01 in a choice of five display formats including timing, mapping. and state table displays in binary, hexadecimal and octal. It imposes no significant electrical characteristics on the 7D01 which affect measurement parameters.

### DF2 CHARACTERISTICS

The DF2 reformats the output of the 7D01 in a choice of seven display formats including timing, mapping, and state table displays in binary, hexadecimal, octal, ASCII and IEEE Standard 488/GPIB. It imposes no significant electrical characteristics on the 7D01 that affect measurement parameters.

#### INCLUDED ACCESSORIES

GPIB Probe Adaptor for the P6451 (103-0209-00). (A 24-pin IEEE Standard Connector with quick connection to the P6451 Probe Head.)

#### MEMORY/SAMPLING RATE

| Format*1 | | Asynchronous*2 | | Synchronous*4 | | |
|---|---|---|---|---|---|---|
| Data Channels Displayed | Bits Per Channel | Maximum Sampling Rate | Minimum Data Pulse Width*3 | Maximum Clock Freq | Data Set-up Time Required | Data Hold Time Required |
| 0-3 | 1016 | 100 MHz | 15 ns | 50 MHz | 20 ns | 0 |
| 0-7 | 508 | 50 MHz | 25 ns | 50 MHz | 20 ns | 0 |
| 0-15 | 254 | 20 MHz | 55 ns | 25 MHz | 23 ns | 0 |

*1 *Front panel selectable.*

*2 *Sampling Intervals are selectable from 10 ns to 5 ms in 18 steps using a 1-2-5 sequence.*

*3 *Minimum data pulse width to insure recording is one sample interval +5 ns.*

*4 *+ or − edge of clock pulse can be selected to initiate sample.*

#### TRIGGER

**Source** — Switches allow selection of pre-, center-, and post-trigger; TTL or variable threshold levels, and use of clock qualification.

**Cursor** — A movable cursor provides a binary data readout of the timing diagram and the number of sample intervals from the data to the trigger position.

### ORDERING INFORMATION

**7D01F** Logic Analyzer (7D01 and DF1 Display Formatter) ..... **$7,550**

**7D01F2** Logic Analyzer (7D01 and F2 Display Formatter) ..... **$8,150**

**7D01** Logic Analyzer ..... **$5,200**

**DF1** Display Formatter ..... **$2,350**

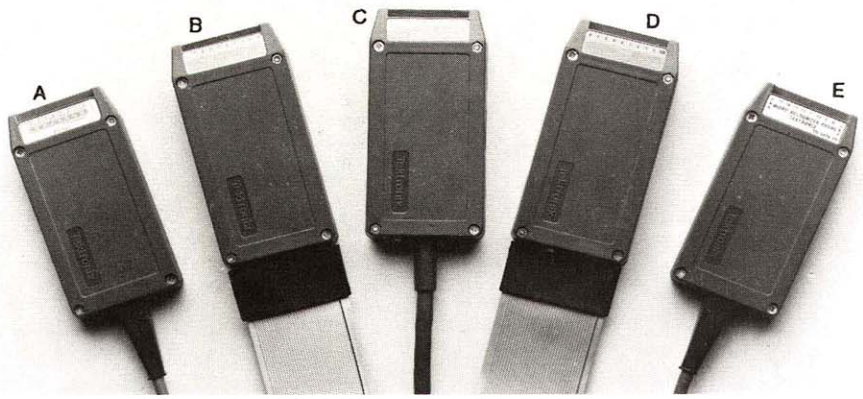
**DF2** Display Formatter ..... **$2,950**

**7603** Oscilloscope ..... **$2,955**

**Option 01** — (Deletes one readout board) ..... **−$350**

**7704A** Oscilloscope ..... **$4,660**

**Option 01** — (Deletes one readout board) ..... **−$350**




**A. P6451 8-Channel Data Acquisition Probe** — For use with 7D01, 7D01F, 7D01F2 and 7D02 Option 01.
Order P6451 (010-6451-03) ..... **$545**

**P6451** — For use with 300 Series instruments (right-angle connector to analyzer).
Order P6451 010-6451-07 ..... **$545**

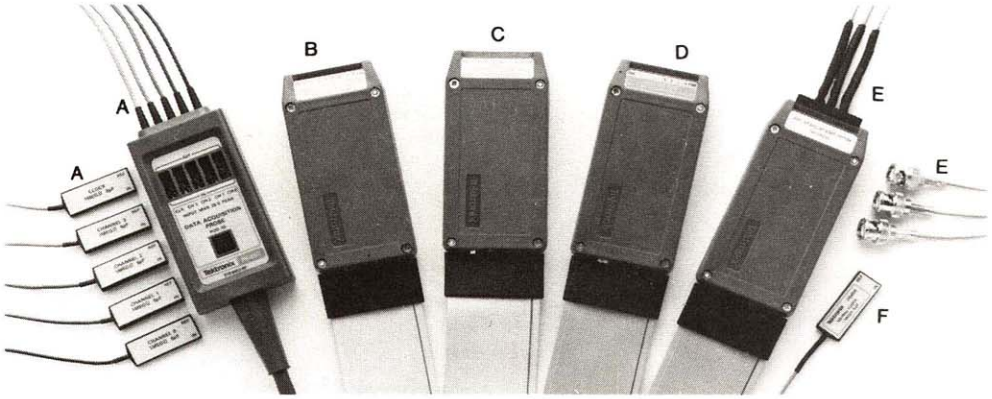
**B. P6452 8-Channel Data Acquisition Probe** — For use with DAS 9100 mainframes, DAS 91A32 modules, and DAS 91A08 modules.
Order P6452 ..... **$730**

**C. P6460 8/9-Channel Data Acquisition Probe** — For use with 1240D1, 1240D2, DAS 91A24 and 91AE24 modules.
Order P6460 ..... **$700**

**D. P6462 8/9-Channel TTL Only Data Acquisition Probe** — For use with 1240D2, DAS 91A24 DAS 91AE24 and DAS 91A32 modules.
Order P6462 ..... **$340**

**E. P6406 16-Channel Word Recognizer Probe** — Replacement for SONY/TEKTRONIX™ 308 Option 01 only.
Order P6406 010-6406-01 ..... **$570**

**All Probes include lead sets.**




**A. P6453 4-Channel Data Acquisition Probe** — High speed probe for DAS 91A04, DAS 91AE04, DAS 91A04A and DAS 91AE04A.
Order P6453 ..... **$1,560**

**B. P6455 TTL/MOS Pattern Generator Probe 8-Channels** — For use with DAS 91P16 and DAS 91P32 modules.
Order P6455 ..... **$575**

**C. P6456 ECL Pattern Generator Probe 8-Channels** — For use with DAS 91P16 and DAS 91P32 modules.
Order P6456 ..... **$575**

**D. P6457 TTL/MOS Pattern Generator Probe, 4-Channels, Individually Tri-Stateable** — For use with DAS 91P16 and DAS 91P32 modules.
Order P6457 ..... **$575**

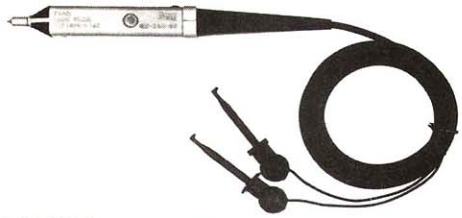
**E. State Stamp Probe** — For use with DAS 9100 system in Digital Design Lab (DDL) Configuration.
Order 021-0366-01 ..... **$1,200**

**F. P6454 100 MHz Clock Probe** — For use with DAS 91A08 module (max of one P6454 per DAS system).
Order P6454 ..... **$265**

**All probes include lead sets.**

**PROBE APPLICATION MATRIX**

| PRODUCT | P6451 | P6452 | P6453 | P6454 | P6455 | P6456 | P6457 | P6460 | P6462 |
|---|---|---|---|---|---|---|---|---|---|
| 91A24, 91AE24 | | | | | | | | ● | ● |
| 91A32 | | ● | | | | | | | ● |
| 91A08 | | ● | | ● | | | | | |
| 91A04A, 91AE04A | | | ● | | | | | | |
| 91P16, 91P32 | | | | | ● | ● | ● | | |
| 1240D1 | | | | | | | | ● | |
| 1240D2 | | | | | | | | ● | ● |
| 338, 318, 308 | ● | | | | | | | | |
| 7D01, 7D02 w/Opt 01 | ● | | | | | | | | |



## P6401 Logic Probe

The small, lightweight, hand-held P6401 indicates the state of logic levels in TTL, DTL, or any other system with threshold between 0.7 volts and 2.15 volts. A strobe input can be used to detect the coincidence of logic signals at two points. An indication of whether a logic pulse has or has not occurred can be obtained in a "store" mode.

Power may be obtained from the unit under test or any 5 V supply.

Two bright lights in the probe tip indicate condition of the logic signal.

### CHARACTERISTICS

**Logic Level Thresholds**
0 or Low (Lamp Extinguishes): +0.7 ± 0.1 V dc.
1 or High (Lamp Illuminates): +2.15 ± 0.15 V dc.

**Minimum Recognizable Pulse Width** — 10 ns.

**Impedance** — ≈7.5 kΩ paralleled by ≈6 pF.

**Minimum Circuit Resistance for Open Circuit Indication** — 10 kΩ.

**Maximum Safe Input** — ± 50 V (dc or RMS).

**Minimum Recognizable Strobe Pulse Width** — 20 ns.

**Maximum Safe Strobe Input** — ±30 V (dc or RMS).

**Strobe Input Impedance** — 5.6 kΩ within 20%.

**INCLUDED ACCESSORIES**

Hook tip (206-0114-00); probe tip to 0.025 in square pin adaptor (206-0137-01); two alligator clips (344-0046-00); strobe lead (175-0958-01); strobe lead (175-0958-00); white plug (348-0023-00); accessory pouch (016-0537-00).

**P6401** Logic Probe.
Order 010-6401-01 ..... **$170**

**Accessory Pouch** — Convenient for carrying manuals, probes and other accessories for 1240 and DAS 9100 logic analyzers
Order 016-0707-00 ..... **$60**

## OPTIONAL ACCESSORIES

**A. Individual Hook Tip Lead Set** — 10 Leads, 16 inch, color coded with E-Z Micro Hook Tips.
Order 012-0670-00 ..... **$65**

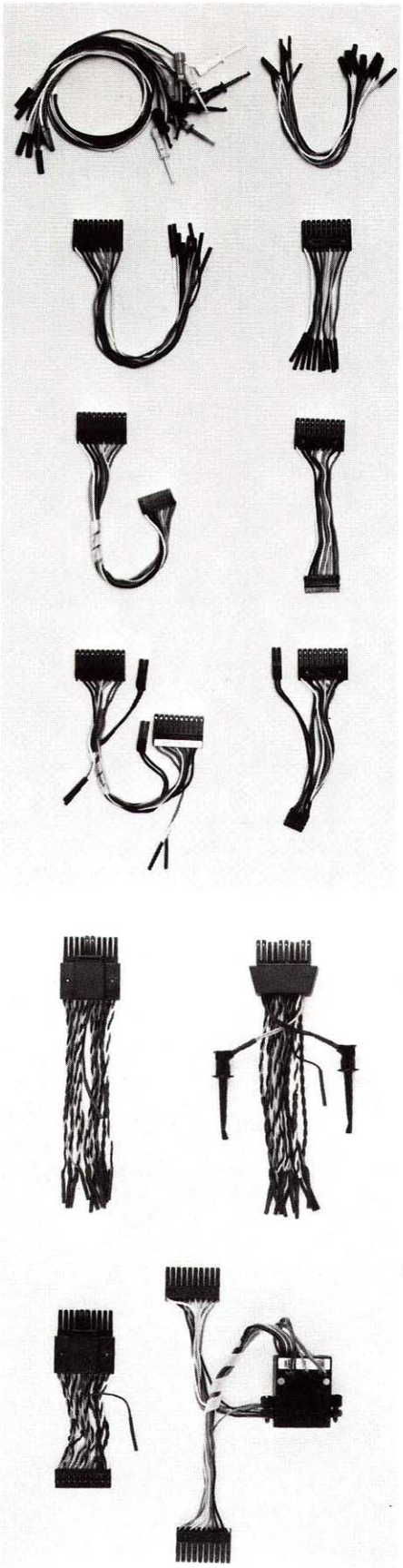
**B. Flying Lead Set** — 10 wide comb, 10 inch, color coded, connects to 0.025 inch square pins, grabber tips not included.
Order 012-0747-00 ..... **$50**

**C. Harmonica Lead Set** — 10 wide comb to 10 position single row connector, for 0.025 inch square pins on 0.1 inch centers, 10 inch, color coded.
Order 012-0800-00 ..... **$30**

**D. Diagnostic Lead Set, DAS 9100** — 10 wide comb to 10 wide comb, and two wide ground jumper, 10 inch, for connecting pattern generator probes to data acquisition probes.
Order 012-1000-00 ..... **$75**

**E. Pattern Generator Lead Set** — 10 + 2 wide comb, 9 inch, twisted pairs, color coded, connects to 0.025 inch square pins, grabber tips not included.
Order 012-0926-00 ..... **$150**

**F. High Speed Pattern Generator Lead Set** — 10 + 2 wide comb to 20 position double row connector, for 0.025 inch square pins on 0.15 inch centers, 5 inch, color coded.
Order 012-1001-00 ..... **$100**




**G. Individual Lead Set** —10 leads, 8 inch, color coded, connects to 0.025 inch square pins, grabber tips not included.
Order 012-0655-02 ..... **$80**

* **Individual Lead Set** — 10 leads, 16 inch, color coded, connects to .025 inch square pins, grabber tips not included.
Order 012-0655-01 ..... **$80**

**H. Flying Lead Set** — 10 wide comb, 5 inch, color coded, connects to 0.025 inch square pins, grabber tips not included.
Order 012-0987-00 ..... **$45**

**I. Harmonica Lead Set** — 10 wide comb to 10 position single row connector, for 0.025 inch square pins on 0.1 inch centers, 5 inch, color coded.
Order 012-0968-00 ..... **$30**

**J. Diagnostic Lead Set, 1240** — 10 wide comb with 2 wide ground to 12 position double row connector, for 0.025 inch square pins on 0.1 inch centers, 10 inch, color coded.
Order 012-0556-00 ..... **$50**

**K. Pattern Generator Lead Set** — 10 + 6 wide comb with VH and VL Pomona Hook Tips, 9 inch, twisted pairs, color coded, connects to 0.025 inch square pins, grabber tips not included.
Order 012-1053-00 ..... **$110**

**L. GPIB Adaptor** — Two 10 wide combs to IEEE Standard 488 Bus Connector, 10 inch.
Order 103-0209-01 ..... **$180**

** Not shown.*

**A. Low Profile Dip Clip** — 40 pin dip to 40 position double row connector, for 0.025 inch square pins on 0.1 inch centers, 4 inch (requires male adaptor below).
Order 015-0339-02 ..... **$44**

* **Low Profile Dip Clip** — 40 pin, same as above except 12 inch.
Order 015-0339-00 ..... **$44**

**B. 40 Pin Male Adaptor** — 40 position double row header with 0.025 inch square pins on 0.1 inch centers, interfaces the PM 101 or flying lead sets to low profile dip clip above.
Order 380-0560-05 ..... **$15**

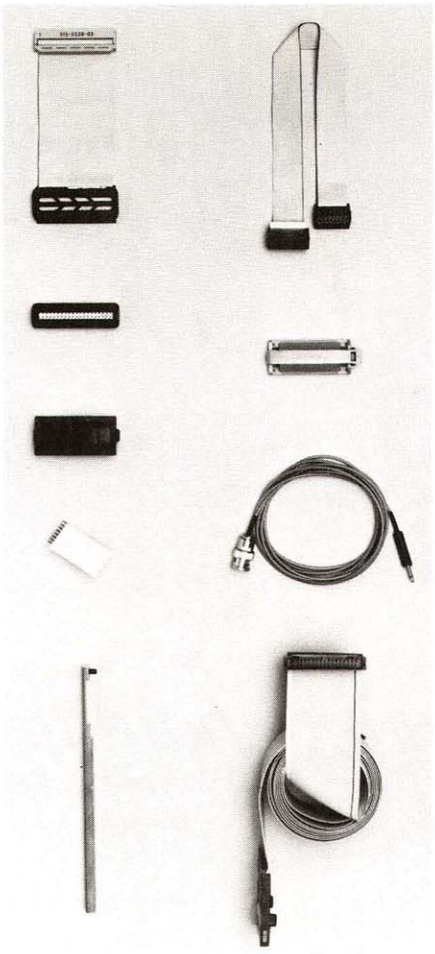
**C. 40 Pin Dip Socket Female Adaptor** — 40 position double row head with 0.025 inch square pins on 0.1 inch centers to 40 pin dip socket, for interfacing 40 pin low profile dip clips to PM 100 series probes.
Order 380-0647-01 ..... **$36**

**D. IC Clip** — 16 pin dip, clothes pin style.
Order 003-0709-00 ..... **$9.50**

* **IC Clip** — 24 pin dip, clothes pin style.
Order 003-0823-00 ..... **$30**

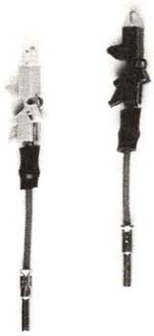
* **IC Clip** — 40 pin dip, clothes pin style.
Order 003-0801-00 ..... **$43**

**E. Circuit Board Ejector Tool** — for removing DAS 9100 module cards.
Order 214-3154-00 ..... **$4.50**




**F. High Speed Grippers** — Package of ten, 1.75 inch, for Dip packages with 0.1 inch lead spacing, use with P6453 or P6454.
Order 195-2234-06 ..... **$75**

* **High Speed Lead Connectors** — Package of ten, gold plated contact pins that interface to podlet lead receptacles on P6453 or P6454.
Order 131-2729-02 ..... **$23**




**G. Sense Leads** — Package of ten, 2 wide comb to Pomona Hook Tip, 5 inch, black for ground or VL.
Order 012-0989-01 ..... **$110**

* **Sense Leads** — Package of ten, 2 wide comb to Pomona Hook Tip, 5 inch, green for ground or VH.
Order 012-0990-01 ..... **$110**

* *Not Shown.*

**H. Low Profile Dip Clip** — 16 pin dip to 16 position double row header with 0.025 inch square pins on 0.1 inch centers, 12 inch.
Order 015-0330-00 ..... **$40**

**I. Flat Cable Mounts** — Adhesive Back for securing and organizing probes with flat ribbon cables.
Order 343-1048-00 ..... **$0.95**

**J. Sync Out Cable** — Minature Phone Plug to BNC, 79 inch, for 91A24 sync output.
Order 175-8165-00 ..... **$29**

* **91AE24 Jumper Cable Replacements** — Package of seven, twisted pair, 2 position connectors, 3 inch.
Order 175-8167-00 ..... **$4.80**

**K. Probe Extender Cable** — Male to Female 34 position double row connectors compatible with P6452, P6460, P6462, 6 feet. Not for use on 91A24 or 91AE24
Order 012-1012-01 ..... **$110**

**L. High Speed Grippers** — Package of ten, 1.75 inch, for flat packages with 0.05 inch lead spacing, use with P6453 or P6454.
Order 195-1943-06 ..... **$75**

* **91AE04A Coaxial Jumper Cables Replacements** — 3 inch, SMA connectors to connect 91A04A to 91AE04A.
Order 175-6425-00 ..... **$18.50**

**M. Grabber Tip** — Package of 12 for general purpose probing with various lead sets or PM 101.
Order 020-0720-00 ..... **$40**

**N. High Speed Clock Lead** — With grabber tip, package of two, for use with P6453 or P6454.
Order 195-3659-00 ..... **$15**

**UPIK 40, Universal Probe Interface Kit** — For 40 pin dip packages. Allows user to configure interconnect from 6 probes or less to a clothes pin style 40 pin IC clip.
Order UPIK 40 ..... **$175**

* **RS-232 Cable** — Male-to-female, 20 inch, wires: 1-1, 2-2, 3-3, 4-4, 5-5, 6-6, 7-7, 8-8, 11-11, 12-12, 15-15, 17-17, 19-19, 20-20, 22-22. Used with 1200C01 modem interface or DAS 9100 line printer and communications interface.
Order 012-0911-00 ..... **$55**

* **RS-232 Cable** — Male-to-female, 2 meter, 25 wires: 1-1, 2-2, 3-3, thru 25-25. General purpose.
Order 012-0815-00 ..... **$55**

* **Null Modem Cable** — Female-to-female, 60 inch, wires: 1-1, 2-3, 3-2, 4-5, 5-4, 7-7, 8-20, 11-11, 12-12, 19-19, 20-8. General purpose.
Order 012-0820-00 ..... **$75**

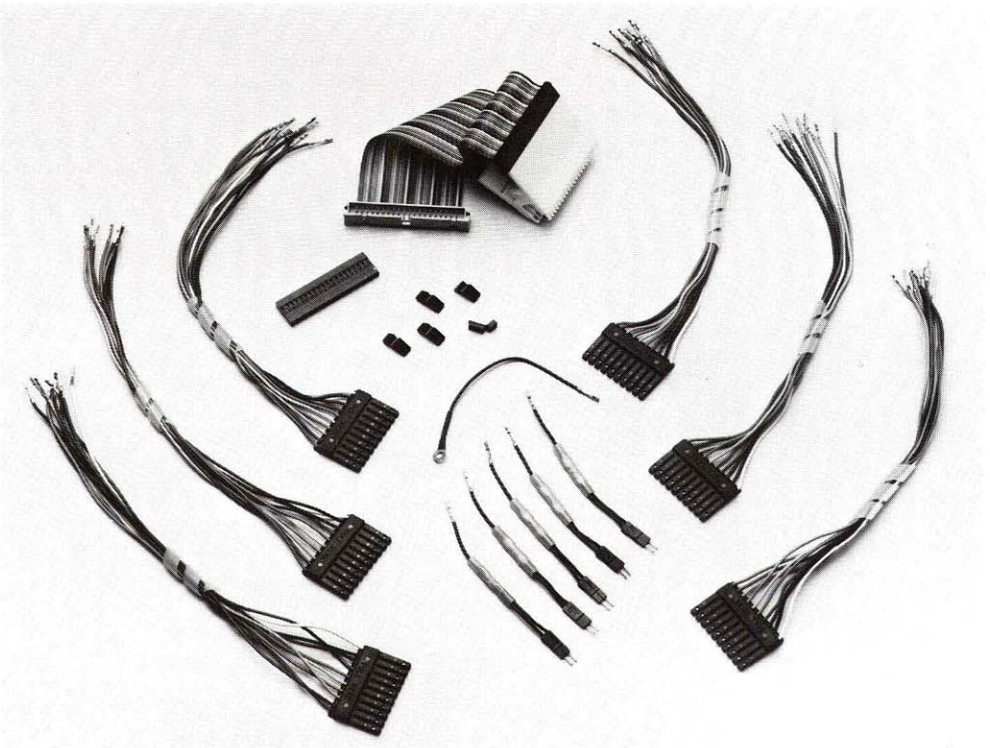
* **Null Modem Cable** — Female-to-female, 60 inch, wires: 1-1, 2-3, 3-2, 4-8, 5-8, 6-20, 7-7, 8-4, 8-5, 20-6. Used with 1200C01 Serial Printer interface.
Order 012-0530-00 ..... **$75**

* **Parallel Interface Cable** — Two meter, used with 1200C11 Parallel Printer COMM Pack for Centronix type printer interface.
Order 012-0997-00 ..... **$55**

* **GPIB Cable** — Two meter.
Order 012-0630-01 ..... **$75**

* **75 Ω Coaxial Cable** — BNC to BNC, 42 inch, used with video hard copy interface.
Order 012-0074-00 ..... **$17.50**

* **75 Ω Coaxial Cable** — BNC to BNC, 120 inch, used with video hard copy interface.
Order 175-2753-00 ..... **$23**



**A. 8 k RAM Pack** — With lithium iodide battery back up, used with 1240.
Order 12RS01 ..... **$300**

A

C **C. Tape Cartridges, DC 100 Type** — Package of five used on DAS 9100 Option 01.
Order 119-1350-01 ..... **$120**

* **Mnemonic Conversion Tape, DAS 9100** — Converts mnemonic and all type files from DAS firmware versions 1.05 and 1.07 to compatability with DAS firmware versions 1.09 or 1.11.
Order 062-6705-00 ..... **$75**

**B. 32K EPROM Pack** — Used with 1240, EPROMs not included. Order 12RS11 ..... **$85**

B

D **D. 32K EPROM Pack** — Used with 1240, four 68764 EPROMs included.
Order 12RS12 ..... **$300**

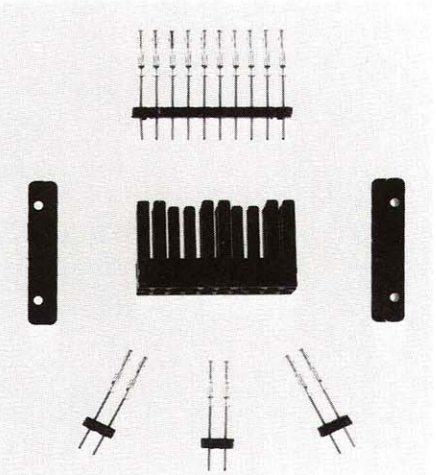
* **SCOPE MOBILE® Cart** — For 1240 and DAS 9100, color compatible brown vinyl finish, see illustration on page 430.
Order 205D ..... **$490**

* **Cart** — K117 Instrument Shuttle. See page 429 for complete description.
Order K117 ..... **$265**

* **Tilt Bail** — For DAS 9100.

* **Rackmount Kit** — For DAS 9100.
Order 016-0463-00 ..... **$200**

* **Rackmount Kit** — For 1240.
Order 016-0789-00 ..... **$200**



E **E. Circuit Board Mounted Probe Connector Kit** — 10 + 6 wide comb to 0.025 inch square pins on 0.15 inch centers, with mounting tabs, for PC mounting, interfaces to the following probes: P6452, P6455, P6456, P6457, P6460, and P6462. Seven piece kit.
Order 020-1027-00 ..... **$35**

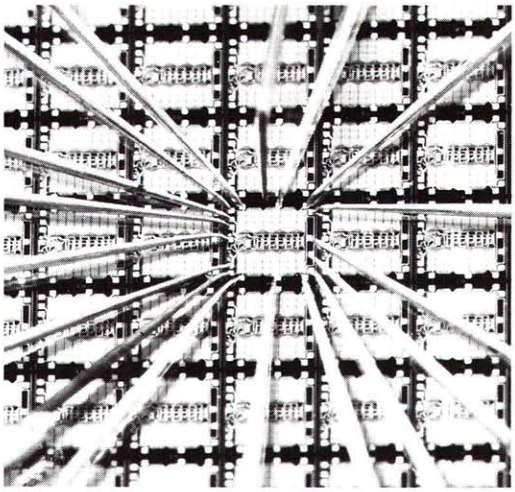
* **DAS 9100 Service Maintenance Kit** — Includes board and cable extenders for DAS modules, power supplies, CRT, and keyboard.
Order 067-0980-00 ..... **$1,250**

* **DAS 9100 Setup and Hold Time Test Fixture** —
Order 067-1037-00 ..... **$1,200**

* **DAS 9100 High Speed Acquisition Test Fixture** — For verification of DAS 91A04, DAS 91AE04, DAS 91A04A, and DAS 91AE04A modules.
Order 067-1139-00 ..... **$250**

** Not shown.*

# SEMICONDUCTOR TEST SYSTEMS



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Tektronix semiconductor test systems are known throughout the electronics industry for their innovative solutions to the latest testing challenges. The S-3200 Series LSI and VLSI test systems have become a key element in engineering and production test facilities throughout the world. Each successive generation of semiconductor devices boasts higher speed, more pins, more functions per chip and more complex testing requirements. Tektronix S-3200 Series systems have met the advancing demands of semiconductor technology with corresponding advances in test capability—features like single-shot time measurement, variable risetime drivers, and powerful data reduction software packages.

Marking the beginning of Tektronix' state-of-the-art test technology development, our first generation automated semiconductor tester, the S-3260, was designed to characterize and test the largest LSI devices in use at the time (four and eight-bit microprocessors, 1 k memories, and peripheral chips). Subsequent systems provided improved device characterization and were designed for quality control in production test environments. Then we tackled the challenge of testing high speed logic and solving the unique problems associated with subnanosecond technologies. Most recently, Tektronix has made the commitment to offer a full range of production-oriented throughput enhancements to its systems. Now, you can put Tek quality into production.

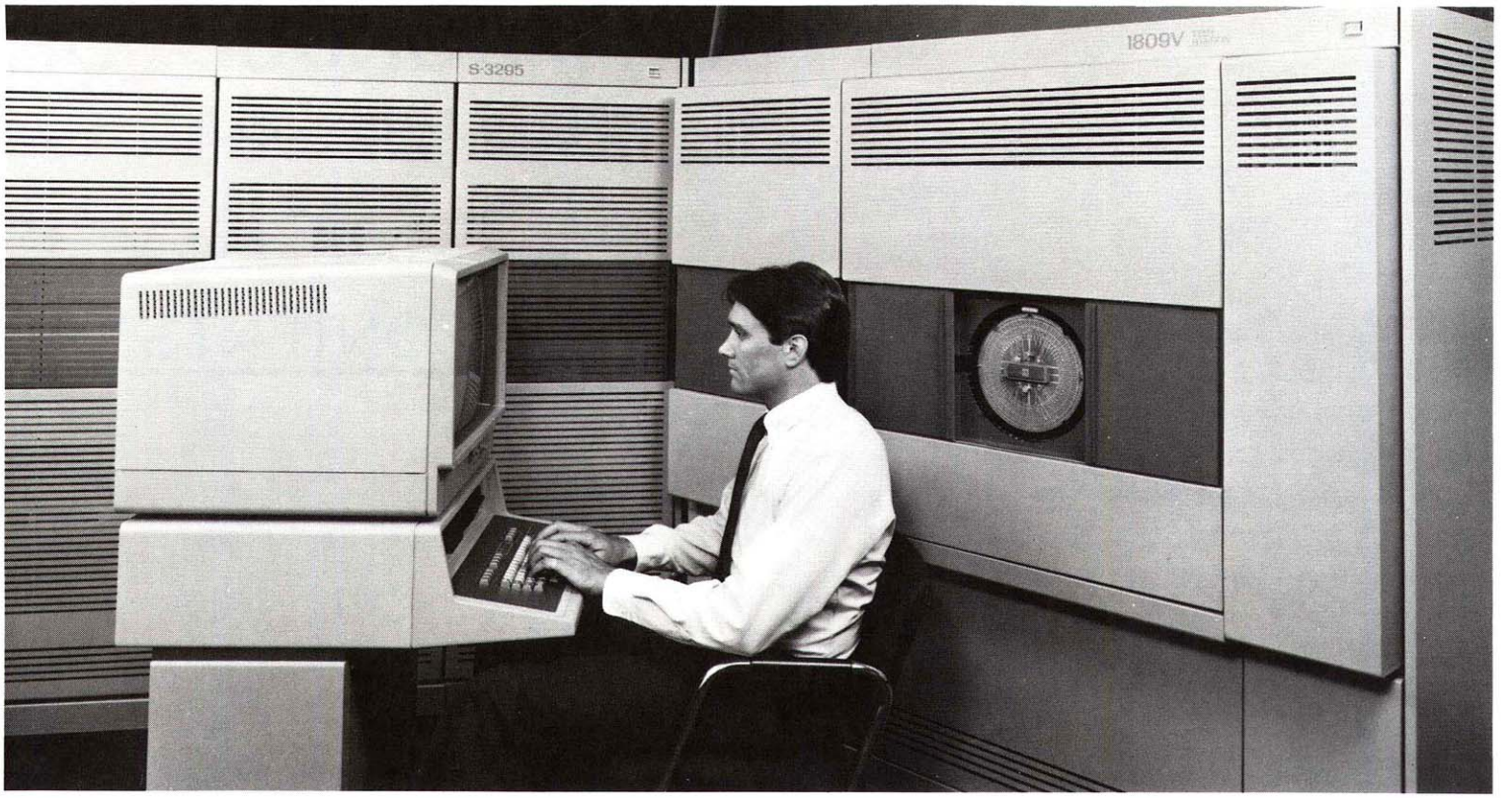
Tektronix provides the hardware, software, training, and applications support to solve today's testing problems, and tomorrow's as well. New and unusual device parameters are viewed as a challenge to our resources, not as insurmountable problems. The field-proven hardware and software in every S-3200 system provides the versatility to get the job done.

Every S-3200 system uses the same highly advanced software—TEKTEST®. So there's only one language to learn. Using TEKTEST, a test engineer can easily and quickly generate and debug programs for device testing or characterization and then transfer these programs from one system to another. And, using our foreground/background capability, up to four users can program or compile data in the background while testing continues uninterrupted in the foreground. A powerful debugging tool, Terminal Control Mode, gives the test engineer interactive control of the test program.

All of the S-3200 systems feature highly sophisticated data reduction and graphics, which make the test results manageable and easy to understand.

We offer analog and digital capability to meet the unique test requirements presented by new and increasingly complex devices. In fact, most manufacturers of captive devices use Tektronix systems for just this reason. Tektronix is also a device manufacturer and has been testing its own ICs and hybrids for years. We have developed expertise and in-depth understanding of complex testing.

At Tektronix, we've built on our past experience and knowledge about device testing to create a total, compatible line of LSI/VLSI test systems that can help solve your test problems — today and in the future.






## S-3295 VLSI Test System

**State-of-the-Art Performance in VLSI Characterization and Production Testing**

**256 Channels, 128 I/O Pins**

**State-of-the-Art Driver/Receiver**

**Programmable Dynamic Loads**

**128 Kilobit Local Pattern Memory**

**Automatic Deskew**

**DEC PDP-11/44 CPU**

**Dynamic Time-Set Selection**

**Advanced Color Graphics and Data Reduction**

**High Precision Combined with High Throughput for Production Applications**

**TEKTEST V, an RSX-11M Based, Super Enhanced TEKTEST Language and User Interface**

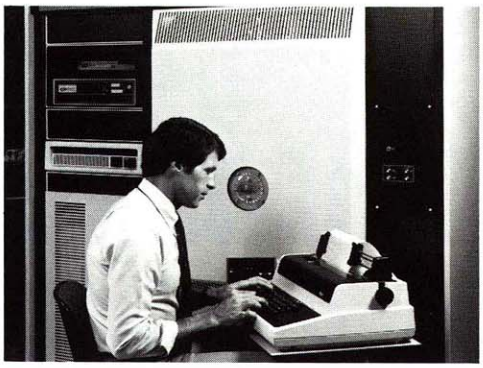
The S-3295 was designed to meet the needs of the user that demands precision, reliability, and efficiency in an automated test system. In applications ranging from the engineering lab to the production test floor, the S-3295 offers a package of features unequaled in the industry. Building on the proven architecture of the S-3200 Series, the S-3295 incorporates significant advances in the areas of realtime pattern generation, timing flexibility/accuracy, resolution, and functional test capability. This system supports up to 256 independent pins (128 I, 128 O), giving it the capacity to test the high pin-count devices that mark the next step forward in semiconductor technology.

Subsystems within the S-3295 include the Pattern Processor, a powerful dedicated pattern computer; the Multi-Set Timing Generator, which provides 16 sets of 16 timing phases, accurate 125 picosecond timing resolution, and split-cycle operation at all clock speeds; and the 1809 V Vertical Test Station that houses the D95 Pin Electronics Cards.

The critical "Device-Under-Test" environment is the foundation upon which an effective testing strategy is built. The S-3295 supports this environment with a pin electronics picture that offers unparalleled versatility and precision. Drawing upon Tektronix' traditional strength in analog design, we have furnished the S-3295 with signal drivers that feature programmable risetime, extremely low inhibit leakage, low aberrations, and wide bandwidth. These drivers are complemented by receivers of comparable performance. The driver/receiver (I/O) pairs are backed up by 128 k of local memory, that can be used as a pattern memory or as an error buffer. The system's 16 clock phases are distributed such that each Dual Pin Electronics Card is fed by 11 phases, meeting the needs of even the most complex digital IC's. Automatic deskew of driver, comparator, and inhibit phases ensures that signal edges will appear in precisely the right relationship. Programmable dynamic output loads eliminate the need for complex external load boards, or alternatively, a 50-ohm resistive load can connect to the DUT output under program control. For testing higher-speed devices, the S-3295 uses a novel multiplexing approach that doubles the effective cycle rate (to 40 MHz) without degrading the signals. A Digital Equipment Corporation PDP-11/44 acts as the system controller and provides up to 4 Megabytes of main memory. The user interface to the system and its controller is a Tektronix 4100 Series color graphics terminal. The color display provides enhanced clarity for all types of data plots—bit maps, shmoo plots, yield analyses, etc.

The S-3295's unique features are integrated with several of the standard features of the S-3200 Series. Among these are the Single Shot Time Measurement Subsystem, the 50-ohm analog switching matrix, the optional Waveform Digitizer, and a host of optional OEM stimulus and measurement equipment. In addition, the S-3295 runs the most powerful test software yet—TEKTEST V. This RSX-11M based test language provides an application-oriented instruction set for device testing, combined with the versatile data handling features of the RSX-11M Operating System.

Of particular interest to those testing devices in a production environment, the S-3295 is now available with a series of throughput-enhancing options that make it into a cost-effective production test system. The exceptional accuracy of the S-3295 permits the use of very tight test tolerances, which results in substantially increased yield figures. This yield improvement, combined with the increased volume of devices tested when using such options as the Quad Site Handler Interface, makes the S-3295 a valuable tool in a broad range of production applications.



## S-3220 LSI Test System

- Full Capability 20 MHz Test System
- Cost-Effective for High-Throughput Production Applications
- Enhanced 1 k Pattern RAM Supplements 4 k per Pin Stored Memory
- Single-Shot Timing Measurement
- Uses TEKTEST®, Allowing Device Characterization Programs to be Condensed and Used in Production Testing
- Up to 128-Pin Test Capability

The S-3220 is offered as a production-oriented complement to the Tektronix S-3270 Test System. Since the S-3220 uses the TEKTEST control software used in all S-3200 systems, programs originally developed for engineering use can easily be condensed and employed in a high volume production or incoming inspection environment. The essential test related features of the larger systems are retained in the S-3220, allowing (with no loss in speed or accuracy) functional or pattern testing as well as dc parametric and single-pass ac parametric testing.

The S-3220 is configured with a vertical pin-electronics package that is integrated with the control/stimulus equipment rack. This feature eases prober/handler mechanical interface and reduces floor space requirements — an important consideration in most production areas.

## S-3270 LSI Test System

- Uninterrupted Error Storage at 20 MHz
- Multiple Pattern Sources
- Versatile Driver Formats
- 14 Programmable Channels of Timing Information
- Test Devices with Up to 128 Pins
- Single-Shot Timing

The S-3270 system tests LSI, microprocessors, analog and digital hybrids, peripheral interface circuits, RAMs, ROMs, and more. Designed to deliver test results on the devices you see everyday. It is also built to deliver results when new devices appear.

With the S-3270, you can perform functional tests at speeds up to 20 MHz. In some cases, the system will test devices that operate at 40 MHz. When you must test a microprocessor at its optimum speed, you need the S-3270.

When testing one of the new, fast devices with the S-3270, you will not have to stop the test to log an error. The S-3270 keeps right on testing while it catches the error and records its location. Input/Output switching may also be performed at a clock rate of 20 MHz.

The fully integrated waveform digitizer allows you to perform linear and analog tests. The system has 64 pin-electronic cards, each with input and output capability, so you can test a device with up to 128-pins. The 14-phase clock gives you many programmable channels of timing information, to properly and effectively test devices.

For total flexibility, the S-3270 features independent control of logic level definition at each driver and receiver. You set the logic level on every input and output channel, so you are not bound by the limits of the system.

**High Performance Drivers (30 V Swing) Allow Versatility in Testing**
The unique Single-Shot Time Measurement technique allows you to make a measurement with 50 ps resolution in one iteration. Dynamic measurements can also be made by moving strobes (iteration) or by using the optional waveform digitizer.

The basic system makes differential voltage measurements on your device with a resolution of 50 $\mu$V. It also features sub-nanoamp current measuring, especially important in testing CMOS devices. Kelvin sensing increases the accuracy of the forced voltage, insuring that the levels at the DUT will be exactly what you ordered.

## S-3280 ECL Test System

- 100 k ECL Testing
- Precision Fixturing
- Subnanosecond Measurements
- High-Speed Drivers
- Sampling for Waveform Analysis
- CML Capability

The S-3280 was designed specifically to solve ECL testing problems. Featuring subnanosecond time measurement capability, the high-speed hardware gives the S-3280 the ability to test ECL devices to their fullest.

One of the more important features of an ECL test system is its ability to make accurate timing measurements. The S-3280 features three methods of making dynamic measurements. First, Delta-T provides measurements with 50 ps resolution on any test vector, at 20 MHz data rate, in a single pass. Second, our Waveform Digitizing (sampling) capability provides 1 ps resolution to digitize and store any waveform for further analysis. Third, for functional testing, the system's strobed comparators will make tests on any or all test vectors at 20 MHz. The system features 1 mV programming resolution with dual-level comparators on every channel.

Because no multiplexing is necessary the system uses the shortest possible path to deliver clean, accurate signals to the device, thus minimizing waveform degradation.

The S-3280 will measure the parameters of today's ECL devices and will continue to be able to test the more advanced high-speed logic devices that are being developed. The S-3280's advanced, high-speed measurement characteristics make it a superior ECL testing solution.

# COMMUNICATIONS PRODUCTS

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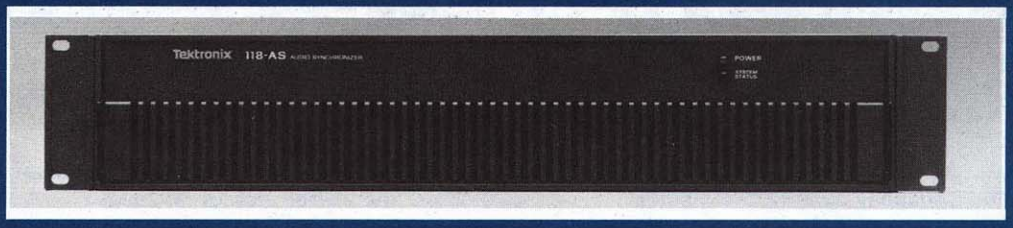
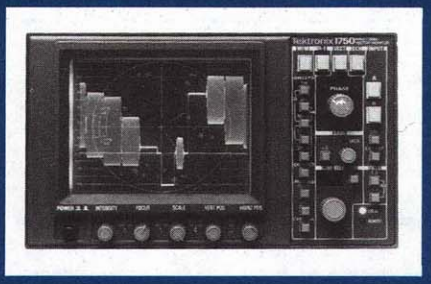
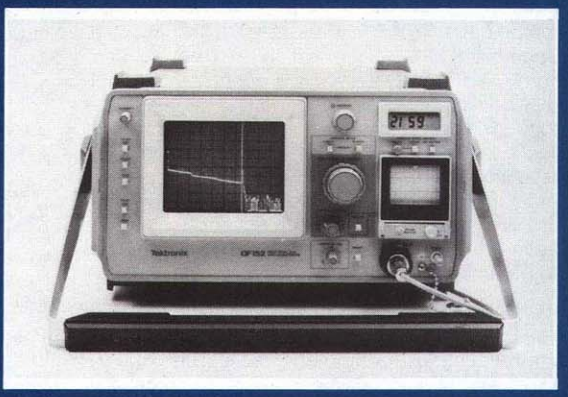
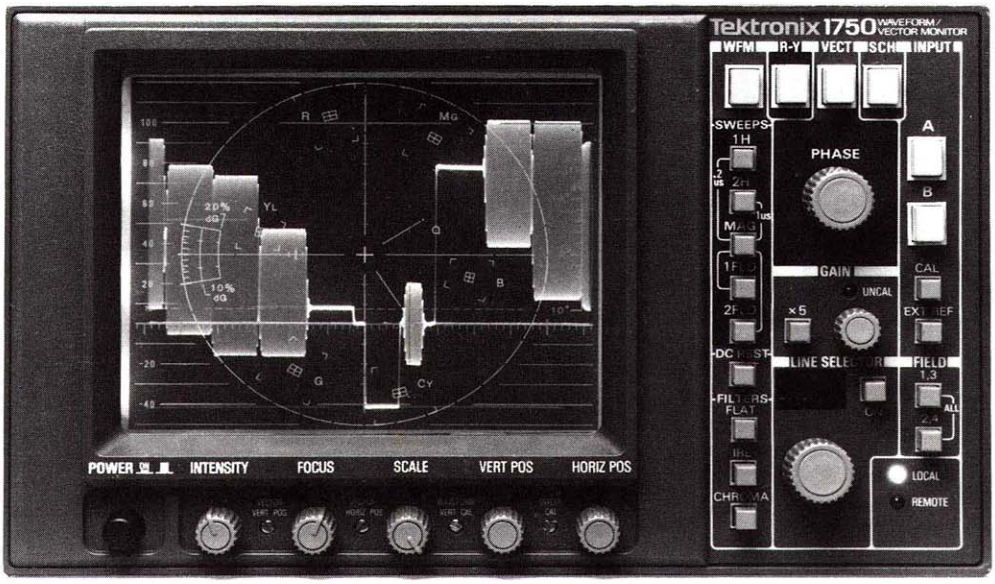




Communications Products are quality instruments designed to test, time, measure and monitor a variety of television, RF, fiber optic, and data communications network signals. The sampling of new products shown here include the 118AS Audio Synchronizer, 1750 Series Waveform/Vector Monitors, the 494P Spectrum Analyzer, and the OF152 Cable Tester.

Electronic communications continue to impact mankind through newer and better equipment and applications. We are proud to be at the leading edge of these new technological opportunities. Through a cohesive network of domestic and international sales and service locations, each with personnel experienced and knowledgeable in the communications marketplace, we bring Tektronix performance and support to our Communications customers throughout the world.




## 1750 Series

- Two Instruments in One
- SCH Phase and Color Framing
- R-Y (V-Axis) Mode
- RGB/YR GB Mode
- Remote Control Capability

**1750 Series**
The Tektronix 1750 Series offers comprehensive monitoring and measurement of television signals, including SCH phase and color framing, in one compact unit. While similar in appearance to the 1740 instruments, the 1750 has enhanced performance in each of its operating modes.

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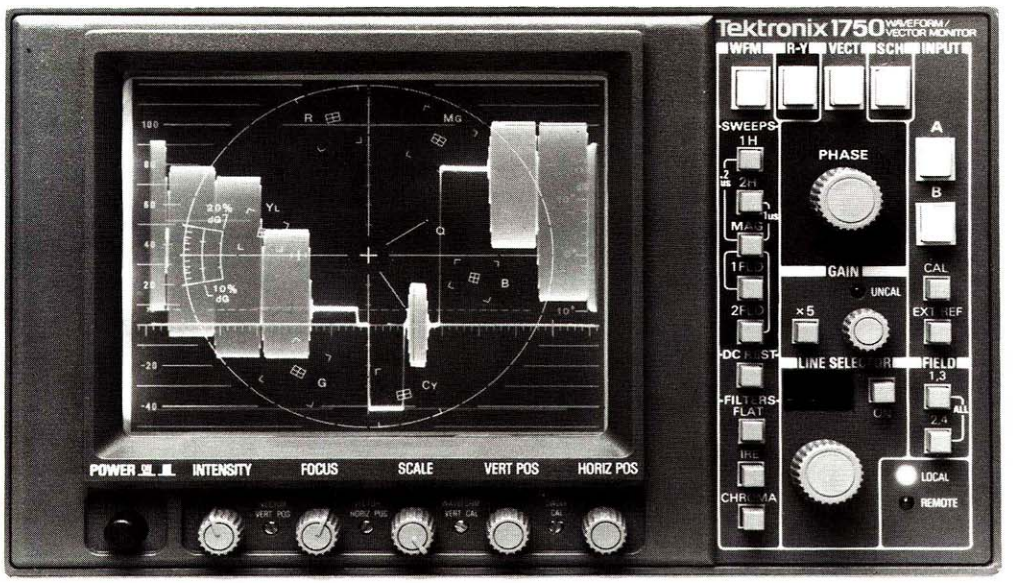



## 1750 Series

- Two Instruments in One
- SCH Phase and Color Framing
- R-Y (V-Axis) Mode
- RGB/YR GB Mode
- Remote Control Capability

The Tektronix 1750 Series offers comprehensive monitoring and measurement of television signals, including SCH phase and color framing, in one compact unit. While similar in appearance to the 1740 instruments, the 1750 has enhanced performance in each of its operating modes.

The unique new SCH phase display presents horizontal sync timing relative to reference subcarrier (burst) for verification of signal format and color framing. This mode enables easy analysis and monitoring of these important characteristics of the television signal; a task which previously required complex techniques, highly skilled operators and/or additional instrumentation. The 1750's SCH phase and color frame displays are derived from the standard composite signals. No extra pulses or added signal details are required.

The 1750's SCH capability makes it particularly valuable in production and editing environments where maintenance of SCH phase and color frame are critical considerations. Applications include VTR bridges, camera control units, switcher consoles, master control, mobile and field production units, and in maintenance operations supporting any of these areas.

The 1750's half-rack package allows easy installation in environments where space and power requirements are important considerations. The 1750 is mechanically compatible with 528A, 602, 1420, and 1740 Series Tektronix instruments.

### Waveform Mode

The waveform mode vertical response is controlled by selectable flat, chroma, and luminance (IRE) filters. A backporch slow clamp is controllable from the front panel. An internal jumper reprograms the clamp timing for sync tip operation.

The 1750 has pushbutton selection of H, 2H, V, and 2 V horizontal sweeps. A magnifier provides calibrated sweep speeds of 1 μs/div, 0.5 μs/div, and 0.2 μs/div at the line display rates, and about 20X magnification of the vertical rate display. The faster sweep speeds are useful for determination of horizontal blanking, pulse widths, risetimes, and other timing details of the signal, while the magnified vertical sweep allows viewing of the vertical blanking interval.

The internal calibrator signal in the 1750 is useful for verification of both video amplitude and sweep timing calibration. Crystal control of the calibrator waveform provides an accurate 1V p-p squarewave and 10 μs timing interval.

The sweeps may be locked to the selected signal (A or B input), or to a separate external reference input. The horizontal rate sweeps may be triggered by the selected source (which presents a stable display in the presence of sync jitter) or may be AFC controlled (which displays sync jitter for analysis). Use of the AFC sweep control can also reposition the H sweep for more convenient timing measurements.

The 1750 Series has front panel line and field selection, an LED readout of the selected line number, and a video output with a strobe pulse on the displayed line. The 1750 (NTSC) will display line 8 thru 23 of either monochrome field (color fields 1,3 or fields 2,4). The 1751 (PAL) will display lines 6 thru 21 or 319 thru 334. The line selection range may be extended to any line of the frame by the use of rear panel remote control input in conjunction with the front panel controls.

The line selection function is operational in waveform, R-Y, and vector modes. These features provide convenient in-service monitoring or measurement of field blanking interval test or data signals.

### R-Y (V-Axis) Mode

In this mode the display is similar to a waveform display with the demodulated chrominance signal on the vertical axis and the selected sweep on the horizontal axis. Any demodulation axis may be set with the phase control; properly setting the display of burst in the vector mode will ensure R-Y axis decoding when the R-Y mode is selected.

There are differential phase markings on the graticule for use in this mode. Resolution of differential phase error is about twice that of vector measurement techniques, and the displayed errors may be correlated with time and luminance amplitude by using modulated staircase or modulated ramp test signals.

### SCH Phase Mode

This display is a combination of the burst vectors of the vector display and a bright dot on the outer degree circle of the vector graticule. The position of this "sync dot" around the circle represents the timing (phase) of the horizontal sync edges relative to the reference subcarrier. An individual signal may be analyzed for proper format (for proper SCH phase) without any additional reference.

Since it is possible for two signals to be properly formatted but not properly timed to each other (i.e., a color framing error exists), the 1750 has provision for using an external reference input for its subcarrier phase reference. When the external reference mode is used, the display shows the burst phase and sync timing of the selected signal relative to the burst of the reference signal, simultaneously indicating the SCH phase of the selected input signal and its color frame relative to the external reference signal.

NEW

## CHARACTERISTICS

### VERTICAL WAVEFORM MODE

**Deflection Factor**
1750: 1 V input for 140 IRE display within 1%. 1751: 1 V input displays 1 V within 1%.

**Gain Ranges** — Input signals between 0.7 V and 2 V can be adjusted to 140 IRE (NTSC) or 1 V (PAL) display.

**Maximum Absolute Input Level** — ±2 V (dc + peak ac).

### FREQUENCY RESPONSE

**Flat** — ±2% from 50 kHz to 6 MHz. ±5% from 6 MHz to 8 MHz.

**IRE (1750)** — Conforms to IEEE Standard 205. Response at 15 kHz does not vary between FLAT and IRE by more than 1%.

**LUM (1751)** — <3 dB down at 1 MHz, >40 dB down at 4.43 MHz, response at 15 kHz does not vary between FLAT and LUM by more than 1%.

**CHROMA (1750)** — Response at 3.58 MHz does not vary between FLAT and CHROMA by more than 1%. Lower: −3 dB point at 2.83 MHz ±0.15 MHz. Upper: −3 dB point at 4.33 MHz ±0.15 MHz. Attenuation at 7.2 MHz >25 dB.

**CHROMA (1751)** — Response at 4.43 MHz does not vary between FLAT and CHROMA by more than 1%. Lower: −3 dB point at 3.68 MHz ±0.15 MHz. Upper: −3 dB point at 5.18 MHz ±0.15 MHz. Attenuation at 8.9 MHz >25 dB.

### RESPONSE DISTORTION

**Preshoot** — 1% or less.

**Pulse-to-Bar Ratio** — 0.99:1 to 1.01:1.

**Overshoot** — 2% or less.

**Ringing** — 2% or less.

**Tilt (Field Rate Squarewave, Vertical Window, or 25 μs Bar)** — 1% or less.

**Differential Gain** — Displayed differential gain is 1% or less with 10% to 90% APL changes.

### PIX MON OUTPUT

**Frequency Response** — 50 kHz to 6 MHz, within 3% of response at 50 kHz.

**Dc Level on Output** — 0.5 V or less into 75 Ω load.

**Output Impedance** — 75 Ω.

**Return Loss** — At least 30 dB, 50 kHz to 6 MHz.

### DC RESTORATION

**Dc Restorer Clamp Time** — Back Porch (Internally selectable to Sync Tip).

**Low-Frequency Response at 60 Hz** — Attenuation of 60 Hz on Input Signal: 20% or less.

**Blanking Level Shift with 10% to 90% APL Change**
1750: APL changes from 50% to either 10% or 90% will cause blanking level shift of 1 IRE unit (7 mV) or less. 1751: APL changes from 50% to either 10% or 90% will cause blanking level shift of 7.2 mV or less.

### CALIBRATOR SIGNAL

**Frequency** — 100 kHz, ±0.1 kHz. Synchronizes in 2H and 1H sweep, providing reference for sweep and magnifier calibration.

**Timing Accuracy** — 10 μs, ±10 ns.

**Amplitude** — 1 V within 0.5%.

### HORIZONTAL DEFLECTION SYSTEM

**Sweep** — Sweep will occur in all horizontal mode settings with or without synchronization.

**Timing Accuracy** — 1 μs/div sweep within 2%. 0.2 μs/div sweep within 2%.

**Linearity** — (1 μs/div and 0.2 μs/div) within 2%.

### SYNCHRONIZATION REQUIREMENTS

**Internal References** — SCH Mode: Composite video or black burst with sync and burst amplitudes 286 mV, (300 mV) ±3 dB. Other Modes: Composite video or black burst with sync and burst amplitudes 286 mV, (300 mV) ±6 dB.

**External References** — Waveform Mode Sync amplitude between 143 mV and 4 V will synchronize sweeps.

**Vector Mode** — Composite video or black burst with sync and burst amplitudes 286 mV, (300 mV) ±6 dB.

**External References Input** — Dc Input Impedance: >15 kΩ. (Unterminated). Return Loss (75 Ω): >40 dB from 50 kHz to 6 MHz.

### RGB/YRGB MODE

Will display either a 3-step or 4-step RGB/YRGB display.

**Staircase Amplitude** — A 10 V input will result in a horizontal display of 9 divisions ±1.4 major divisions.

**Maximum Operating Staircase Signal Voltage** — 12 V p-p ac component. Signal voltage not to exceed ±12 V Dc plus peak ac.

### VECTOR MODE

**Chrominance Bandwidth** — Upper: −3 dB Point Fsc +500 kHz, ±100 kHz.
Lower: −3 dB Point Fsc −500 kHz, ±100 kHz.

**Vector Phase Accuracy** — Within 1.25°.

**Vector Gain Accuracy** — 1750: Within 1.25 IRE.
1751: Within 2.5%.

**Quadrature Phasing** — Within 0.5°.

### SCH MODE

**Accuracy** — Absolute: ±5° phase at 25° C. Relative: ±2°. Acquisition Time: <1 s.

### SUBCARRIER REGENERATOR

**Pull-In Range** — 1750: Within 50 Hz of Fsc.
1751: Within 10 Hz of Fsc.

**Phase Shift with Subcarrier Frequency Change** — 1750: Within 0.5° from Fsc to (Fsc +50 Hz), or Fsc to (Fsc −50 Hz). 1751: Within 0.5° from Fsc to (Fsc +10 Hz), or Fsc to (Fsc −10 Hz).

**Phase Shift with Burst Amplitude Change** — Within 2° from nominal burst amplitude to ±6 dB.

**Phase Shift with Reference Switched Between Internal & External References** — Within 0.5°.

**Phase Shift with Input Channel Change** — Within 0.5°.

**Phase Shift with X5 Gain** — Within 2°.

**Phase Shift with Variable Gain** — Within 1° as gain is varied from +3 dB to −6 dB.

**Phase Control Range** — 360° continuous rotation.

### DISPLAY CHARACTERISTICS

**Differential Phase** — Within 1°.

**Differential Gain** — Within 1%.

**Variable GAIN Range** — Input subcarrier signals between 210 mV and 1.05 V can be adjusted to normal burst vector length (may be extended to 43 mV via X5 gain).

### CRT DISPLAY

**CRT Viewing Area** — 80 mm x 100 mm.

**Graticule** — Dual internal, variable SCALE illumination.

### POWER SOURCE

**Mains Voltage Ranges** — 115 V (90 V to 132 V); 230 V (200 V to 250 V).

**Mains Frequency Range** — 48 Hz to 66 Hz.

**Power Consumption** — 48 W.

### ENVIRONMENTAL CHARACTERISTICS

**Temperature** — Operating: 0° C to +75° C. Nonoperating: −55° C to +75° C.

**Altitude** — Operating: To 5500 m (15,000 ft). Nonoperating: To 18 000 m (50,000 ft).

### CERTIFICATION

**Safety/EMC** — UL 1244. Factory Mutual-3820. CSA Bulletin 556B. IEC 348.

**FCC EMC Compatibility** — (FCC Rules Part 15 Subpart J, Class A). VDE 0871.5 (Class B).

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 216 | 8.5 |
| Height | 133 | 5.3 |
| Depth | 460 | 18.2 |
| **Weights** | **kg** | **lb** |
| Net | 8.0 | 18.0 |

### INCLUDED ACCESSORIES

Power cord assembly (161-0066-00); clear filter (378-0219-00); contrasting filter (378-0221-01); female remote connector, 25 pin (131-0569-00); 9 pin (131-1006-00); remote connector housing, 25 pin (200-1667-00); 9 pin (200-1170-00); strain relief, 25 pin (358-0314-00); 1.0 A fuse (159-0022-00); 0.5 A fuse (159-0032-00); instruction manual (070-4472-00).

## ORDERING INFORMATION

**1750** Waveform/Vector Monitor (for NTSC Applications) ..... **$5,900**
**1751** Waveform/Vector Monitor (for PAL Applications) ..... **$5,900**

### OPTIONAL ACCESSORIES

**Battery Pack** — Order BP1 ..... **$550**
**Snap-On Front Cover** — High impact plastic. Order 200-1566-00 ..... **$18**
**Modular Carrying Case** — Portable case with handle, feet, and battery mounting lugs (lugs are required to mount the BP1). Order 020-1241-01 ..... **$120**
**Carrying Case** — Painted (blue), with handle and feet. Order 390-0018-01 ..... **$85**
**Cover** — Unfinished aluminum, no handle or feet. Order 437-0100-01 ..... **$60**
**Side-By-Side Rack Mount** — For mounting two half-racks (1750, 528A, etc). In a standard 19 in rack Order 016-0115-02 ..... **$225**
**Blank Panel** — For the side-by-side rack mount. Order 016-0116-00 ..... **$42**
**Flip Stand Feet** — For modular carrying case, stands extend normal feet for tilted viewing (two required). Order 348-0618-01 ..... **$5.75**
**Viewing Hood** — For high ambient light environments. Order 016-0475-00 ..... **$8.25**
**Camera** — Use C-30 Option 01 with adaptor 016-0269-03, or C-5C Option 02 or 04, or standard C-4. (See camera section of this catalog.)

### MAINTENANCE ACCESSORIES

**Extender Board** — 64 pin Order 670-7980-00 ..... **$47**
**Extender Board** — 32 pin Order 670-7981-00 ..... **$55**
**Extender Cable** — Order 067-0709-00 ..... **$45**
**Deflection Leads Extender Cables** — (Four each) Order 196-0939-00 ..... **$6.00**

## 1740 Series

- Two Instruments in One
- Optional Dc Power Capability
- Bright CRT Display
- R-Y (V-Axis) Mode
- VITS Monitoring
- RGB/YRGB Display Capability
- Remote Control Capability
- Available in NTSC, PAL, and PAL-M

*1741 Waveform/Vector Monitors with optional carrying case and battery pack.*

Similar to the 528A and 1420 Series products, the 1740 Series provides all the basic waveform monitoring and vectorscope functions, but in a single, compact package. In addition, the 1740 Series adds dc power operation (optionally), single line vertical interval display which is internally preset, an R-Y/sweep mode for differential phase measurements, and remote control of waveform/vector mode and most of the front panel sweep and vertical amplifier response functions.

The 1740's half-rack width package allows easy installation where space and power requirements are important considerations. The 1740 is mechanically compatible with the 528A, 602, 1420 and 1750 Series instruments.

Typical applications include video signal monitoring in VTR bridges, camera control units, production switcher consoles, and in mobile vans and field productions.

### Optional Dc Power Capability

Two instrument options provide a dc Input for powering the monitor from a 12 volt dc power source. Option 07 provides the dc capability. Option 11 provides the dc capability and includes a portable case and the BP1 Battery Pack as the power source. The BP1 quickly and securely mounts to the bottom of the portable case. Total package weight of the instrument with the BP1 mounted is approximately 13.6 kg (30 lb).

A 1740 Series instrument will operate from a BP1 for at least two hours before recharging is required. Spare BP1 Battery Packs are available as optional accessories.

### Bright CRT Display

The bright CRT display permits use of the 1740 Series in high ambient light conditions, such as those encountered in field production applications. Brightness remains high in the 1 μs and 0.5 μs magnified sweep speeds, thus enhancing the 1740's use in system phasing applications. The internal waveform graticule and the external vector graticule are independently illuminated. A parallax free composite internal graticule, including both the waveform and vector features, is available (Option 06).

### R-Y (V-Axis) Mode

The demodulated chrominance may be displayed with a horizontal sweep using the R-Y mode for NTSC signals or the V-Axis mode for PAL or PAL-M signals. When the burst is phased properly in the vector mode, the R-Y mode displays the chrominance demodulated on the R-Y axis (V-axis in PAL systems). There are differential phase markings on the right side of the vector graticule that are calibrated for use in this mode. Different sweep speeds may be used to examine differential phase as a function of time.

### VITS Monitoring

VITS (Vertical Interval Test Signals) or ITS (Insertion Test Signals) can be monitored in all modes. Each instrument model is internally set for a particular line. The 1740 is set to display line 19, usually occupied by the VIRS. The 1741 is set to line 17/330, and the 1742 to line 17/280. The 1740 may be reset for any line from 6 through 36, the 1741 from line 3/316 through 33/346, and the 1742 from line 3/266 through 33/296.

### RGB/YRGB Display

Facilities for a parade display of camera RGB signals are included in all 1740 Series instruments. The monitor's REMOTE connector accepts the required enable and 3-step staircase signals from the camera. An internal jumper change permits display of a YRGB parade signal.

### Remote Control Capability

Remote control of input channel selection, mode, sweep speeds, and vertical amplifier filters is available through a rear panel connector. The remote function is useful for VTR applications.

## ELECTRICAL CHARACTERISTICS

### VERTICAL WAVEFORM MODE

**Deflection Factor**
1740: 140 IRE display within 1% with 1 V input.
1741/1742: 1 V display within 1% with 1 V input.

**Variable Gain Range**
1740: Input signals between 0.7 V and 2 V can be adjusted to 140 IRE display.
1741/1742: Input signals between 0.7 V and 2 V can be adjusted to 1 V display.

**Maximum Absolute Input Level** — ±2 V (dc + peak ac).

**Video Input Return Loss** — At least 40 dB from 50 kHz to 6 MHz.

### FREQUENCY RESPONSE

**FLAT** — ±2% from 50 kHz to 6 MHz. ±5% from 6 MHz to 8 MHz.

**IRE (1740)** — Conforms to IEEE Standard 205. Response at 15 kHz does not vary between FLAT and IRE by more than 1%.

**LUM (1741/1742)** — <3 dB down at 1 MHz, >40 dB down at 4.43 MHz, response at 15 kHz does not vary between FLAT and LUM by more than 1%.

**CHROMA (1740/1742)** — Response at 3.58 MHz does not vary between FLAT and CHROMA by more than 1%.
Lower: −3 dB point at 2.83 MHz to ±0.15 MHz.
Upper: −3 dB point at 4.33 MHz to ±0.15 MHz.
Attenuation at 7.2 MHz: >25 dB.

**CHROMA (1741)** — Response at 4.43 MHz does not vary between FLAT and CHROMA by more than 1%.
Lower: −3 dB point at 3.68 MHz to ±0.15 MHz.
Upper: −3 dB point at 5.18 MHz to ±0.15 MHz.
Attenuation at 8.9 MHz: >25 dB.

### RESPONSE DISTORTIONS

**Preshoot** — 1% or less.

**Pulse-to-Bar Ratio** — 0.99:1 to 1.01:1.

**Overshoot** — 2% or less.

**Ringing** — 2% or less.

**Tilt (Field Rate Squarewave, Vertical Window, or 25 μs Bar)** — 1% or less.

**Differential Gain** — Displayed differential gain is 1% or less with 10% to 90% APL changes.

### VIDEO OUTPUT

**Frequency Response** — 50 kHz to 6 MHz, within 3% of response at 50 kHz.

**Dc Level on Output** — 0.5 V or less into 75 Ω load.

**Output Impedance** — 75 Ω.

**Return Loss** — At least 30 dB, 50 kHz to 6 MHz.

### DC RESTORATION

**Dc Restorer Clamp Time** — Back porch (Internally selectable to sync tip).

**Low-Frequency Response at 60 Hz** — Attenuation of 60 Hz or input signal: 20% or less.

**Blanking Level Shift with APL Change**
1740: APL changes from 50% to either 10% or 90% will cause blanking level shift of 1 IRE unit or less.
1741/1742: APL changes from 50% to either 10% or 90% will cause blanking level shift of 7.2 mV or less.

### CALIBRATOR SIGNAL

**Frequency** — 100 kHz, ±0.1 kHz. Synchronizes in 2H and 1H sweep, providing reference for sweep and magnifier calibration.

**Amplitude** — 1 V display within 0.5%.

### HORIZONTAL DEFLECTION SYSTEM

**Timing Accuracy** — 1 μs/div sweep within 2%. 0.5 μs/div sweep within 3%.

**Linearity** — 1 μs/div and 0.5 μs/div within 2%.

### SYNCHRONIZATION REQUIREMENTS

**Internal References**
1740: Composite video or black burst with sync and burst amplitudes 40 IRE to ±6 dB.
1741/1742: Composite video or black burst with sync and burst amplitudes 300 mV to ±6 dB.

**External References** — Waveform Mode: Sync amplitude between 143 mV and 4 V will synchronize sweeps.

**Vector Mode**
1740: Composite video or black burst with sync and burst amplitudes 40 IRE to ±6 dB.
1741/1742: Composite video or black burst with sync and burst amplitudes 300 mV to ±6 dB.

### EXTERNAL REFERENCES INPUT

**Dc Input Impedance** — >15 kΩ.

**Return Loss** — At least 40 dB from 50 kHz to 6 MHz.

### RGB/YRGB MODE

Will display either a 3-step or 4-step RGB/YRGB display.

**Staircase Amplitude** — A 10 V input will result in a horizontal display of 9 divisions ±1.4 major divisions.

**Maximum Operating Staircase Signal Voltage** — 12 V p-p ac component. Signal voltage not to exceed ±12 V dc + peak ac.

### VECTOR MODE

**Chrominance Bandwidth**
Upper: −3 dB point Fsc +500 kHz ±100 kHz.
Lower: −3 dB point Fsc −500 kHz ±100 kHz.

**Vector Phase Accuracy** — Within 1.25 degrees.

**Vector Gain Accuracy** — 1740: Within 1.25 IRE.
1741/1742: Within 1.25%.

**Quadrature Phasing** — Within 0.5 degrees.

### SUBCARRIER REGENERATOR

**Pull-In Range** — 1740: Within 50 Hz of Fsc.
1741/1742: Within 10 Hz of Fsc.

**Phase Shift with Subcarrier Frequency Change** — 1740: Within 0.5 degrees from Fsc to (Fsc +50 Hz), or Fsc to (Fsc −50 Hz).
1741/1742: Within 0.5 degrees from Fsc to (Fsc +10 Hz), of Fsc to (Fsc −10 Hz).

**Phase Shift with Burst Amplitude Change** — Within 2 degrees from nominal burst amplitude to ±6 dB.

**Phase Shift with Reference Switched Between Internal and External References** — Within 0.5 degrees.

**Phase Shift with Input Channel Change** — Within 0.5 degrees.

**Phase Shift with X5 Gain** — Within 2 degrees.

**Phase Shift with Variable Gain** — Within 1 degrees as gain is varied from +3 dB to −6 dB.

**Phase Control Range** — 360 degrees continuous rotation.

### DISPLAY CHARACTERISTICS

**Differential Phase** — Within 1 degree.

**Differential Gain** — Within 1%.

**Variable Gain Range** — 1740: Input subcarrier signals between 28 IRE and 140 IRE can be adjusted to normal burst vector length.
1741/1742: Input carrier signals between 210 mV and 1.0 V can be adjusted to normal burst vector length.

### CRT DISPLAY

**CRT Viewing Area** — 80 mm x 100 mm.

**Accelerating Potential** — Nominally 15 kV.

### GRATICULE

**Waveform** — Internal, variable illumination.

**Vector** — External, variable illumination. Illuminated with VECTOR or R-Y mode selected.

### POWER SOURCE

**Mains Voltage Ranges** — 100 V (90 V to 100 V); 120 V (108 V to 132 V); 220 V (200 V to 242 V); 240 V (218 V to 250 V).

**Mains Frequency Range** — 48 Hz to 66 Hz.

**Power Consumption** — 50 W maximum in ac. 30 W nominal in dc.

### DC BATTERY OPERATION (OPTION 07)

**Voltage Input Range** — 11 V to 16 V.

**Over Voltage and Polarity Reversal Protection** — Fuse blows if >20 V dc or opposite polarity is applied to the dc INPUT.

**Under Voltage Protection** — Instrument shuts down when battery voltage (under load) is below 9 V.

**Battery Current** — 3.5 A or less at 12 V.

### ENVIRONMENTAL CHARACTERISTICS

**Temperature** — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Altitude** — Operating: 4500 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

### CERTIFICATION

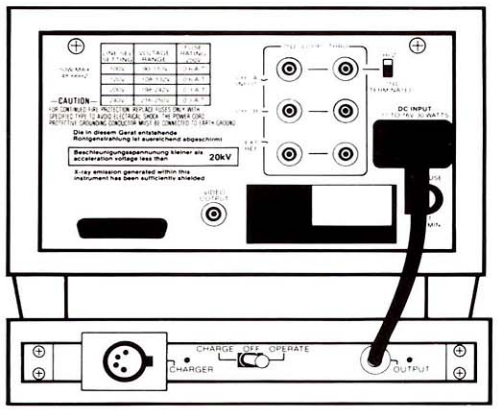
**Safety/EMC** — UL 1244.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 216 | 8.5 |
| Height | 133 | 5.3 |
| Depth | 460 | 18.1 |
| **Weight** | **kg** | **lb** |
| Net | 8.2 | 18.8 |
| Battery Pack | 13.6 | 30.0 |

### INCLUDED ACCESSORIES

0.3 A fuse (159-0029-00); 0.6 A fuse (159-0043-00); Power cord assembly (161-0066-00); clear filter (378-0219-00); female remote connector, 25 pin (131-0569-00); remote connector housing, 25 pin (200-1667-00); strain relief, 25 pin (358-0314-00); instruction manual (070-4473-00).




*Rear panel with optional battery pack attached.*

## ORDERING INFORMATION

These instruments are configured for rackmounting and are shipped without cases or covers. Order appropriate options or optional accessories to configure for bench or portable use.

**1740 Option 01** Waveform/Vector Monitor (For NTSC applications) ..... **$3,970**

**1741 Option 01** Waveform/Vector Monitor (For PAL applications) ..... **$3,970**

**1742 Option 01** Waveform/Vector Monitor (For PAL-M applications) ..... **$4,370**

**Option 06** — (Composite internal graticule, waveform and vector) ..... **+$30**

**Option 07** — (Adds dc power operation capability, must be installed during manufacture) ..... **+$60**

**Option 11** — (Portable carrying case, dc power operation, and a BP1 Battery Pack) ..... **+$650**

### OPTIONAL ACCESSORIES

**Battery Pack** — Order BP1 ..... **$550**

**Snap-On Front Cover** — High import plastic. Order 200-1566-00 ..... **$18**

**Modular Carrying Case** — Portable case with handle, feet, and battery mounting lugs (lugs are required to mount the BP1). Order 020-1241-00 ..... **$120**

**Carrying Case** — Painted (blue), with handle and feet. Order 390-0018-01 ..... **$85**

**Cover** — Unfinished aluminum, no handle or feet. Order 437-0100-01 ..... **$60**

**Side-by-Side Rack Mount** — For mounting two half-racks (1740, 528A, etc) in a standard 19 in rack. Order 016-0115-02 ..... **$225**

**Blank Panel** — For one half of the side-by-side rack mount. Order 016-0116-00 ..... **$42**

**Flip Stand Feet** — For modular carrying case, stands extend normal feet for tilted viewing (two required). Order 348-0618-01 ..... **$5.75**

**Viewing Hood** — For high ambient light environments. Order 016-0475-00 ..... **$8.25**

**Camera** — Use C-30 Option 01 with adaptor 016-0269-03, C-5C Option 02 or 04, or standard C-4, (See camera section of this catalog.

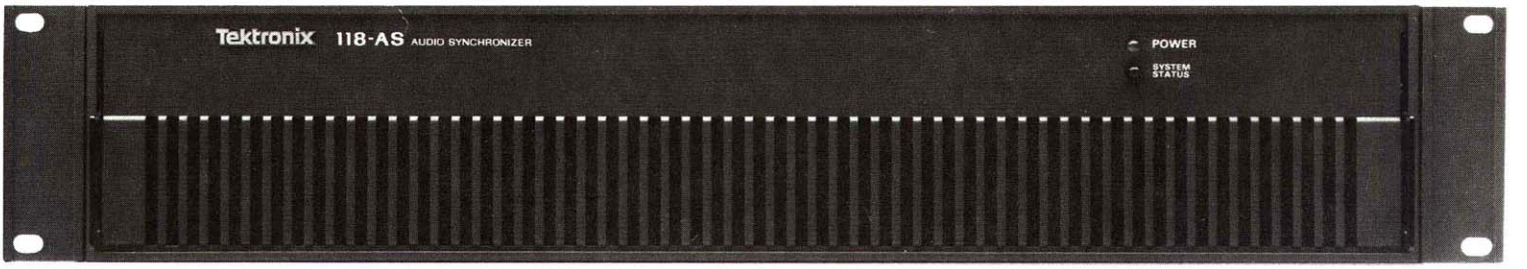
### MAINTENANCE ACCESSORIES

**Extender Board** — 64 pin. Order 670-7980-00 ..... **$47**

**Extender Cable** — Order 067-0709-00 ..... **$45**

**Deflection Leads Extender Cables** — (Four each). Order 196-0939-00 ..... **$6.00**

NEW




## 118-AS

**Automatic or Manual Control of Audio to Video Timing**

**Compensates for up to Ten Fields of Video Display**

**Program Signal Quality Maintained when Changing Delay**

**Simple One-Wire Interface to 110-S Video Synchronizer**

**18-Bit Floating Point Code for Wide Dynamic Range**

**93.75 kHz Sampling Provides Flat Frequency and Phase Response**

**Built-In Diagnostics**

**Easy Module Access for Service**

Frame synchronizers, digital video effects, noise reducers, and other video delay devices in the television signal path necessitate delaying the audio signal to avoid annoying lip-sync errors. When a number of video synchronizers are cascaded, each with its inherent delay variations, fixed audio delays leave significant delay uncertainty. With four-field video synchronizers such as the Tektronix 110-S, video delay may be as great as 66 ms, making audio synchronization even more important. The Tektronix 118-AS Audio Synchronizer provides automatic and/or manual control of audio delay to maintain proper audio to video timing. With 18-Bit floating point code and 93.75 kHz sampling, the Tektronix 118-AS brings to audio synchronization the same high standards established for video synchronization by the Tektronix 110-S.

### Automatic Audio Synchronization

The 118-AS Audio Synchronizer automatically tracks the 110-S Video Synchronizer using a simple one-wire digital interface. Additional audio delay may be added manually to compensate for audio to video timing errors present on an incoming signal. The standard 118-AS provides up to ten fields delay, with memory sockets for user expansion to 40 fields. An optional video interface board allows the 118-AS to be used with other video equipment.

### 118-AS Audio Synchronizer Configuration

The standard 118-AS is a single channel audio synchronizer, which may be expanded to two or three channels for stereo or second language applications. Each additional channel may be added by installing a 118-F01 kit, which consists of two fully calibrated plug-in circuit boards. The 118-AS mainframe is prewired to accept up to three channels. All channels may be controlled by a single video synchronizer or each channel may be operated independently using three 110-S synchronizers.

### Remote Control

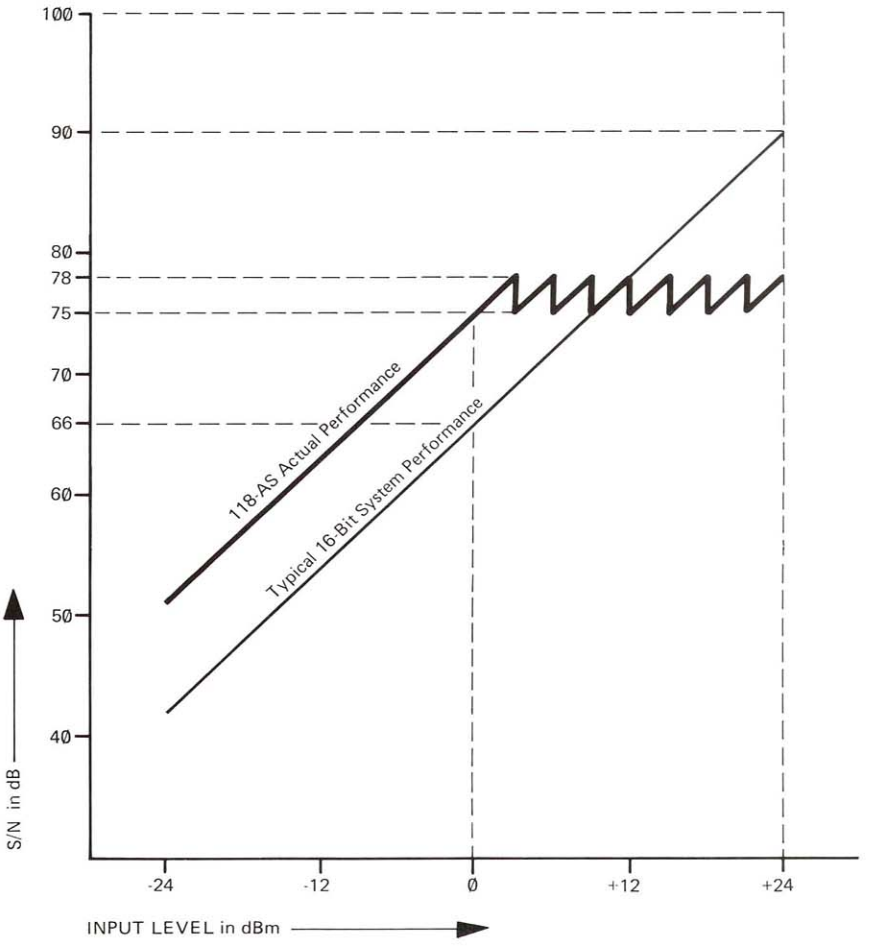
The 118-RC Audio Synchronizer Control allows remote adjustment and monitoring of delay for up to three channels. Automatic, manual, or total delay is displayed in either fields or milliseconds. System Status, Input Clip, and Bypass LEDs indicate abnormal operating conditions. The 118-AS can be bypassed from the Remote Control.

### Transparent Delay Change

To minimize program audio discontinuities, the 118-AS provides a controlled rate of audio delay change. This allows color frame boundary crossings without introducing audible artifacts. Manual delay changes are also rate controlled to guarantee smooth transitions.

### Wide Dynamic Range

Precision floating point coding makes high signal to noise ratio and low distortion available over a wide range of input signal levels. The 118-AS floating point code provides nearly constant 75 dB S/N and 0.05% distortion over a wide range of signal levels instead of optimizing performance for a specification at clip level. While conventional 16-Bit linear coding could provide 96 dB S/N and an impressive .002% distortion just below clipping (where most digital audio devices are specified), performance degrades substantially at lower, more realistic input signal levels, as illustrated in Figure 1. For example, if 16 dB headroom and 25 dB program dynamic range are allowed, a 16-Bit linear PCM system might have 50 dB S/N and 0.2% distortion.




*Signal-to-noise ratio in floating point and linear PCM systems.*

AUDIO SYNCHRONIZER

*118-RC remote control unit*

NEW

### Wide Bandwidth

A fundamental constraint of digitizing either audio or video is that all frequencies above half the sample rate must be removed to avoid aliasing (see Figure 2). For example, with a typical 44 kHz sample rate and 20 kHz audio bandwidth only a 4 kHz transition band for the anti-aliasing filters is allowed. This necessitates performance tradeoffs in frequency response and group delay. If compromises are made in filter design, aliasing may translate out-of-band energy, such as tape recorder bias frequencies, into the audio band.

With a sample rate of 93.75 kHz, the 118-AS filter transition band increases from 4 kHz to 53.75 kHz. As a result, wide frequency response, flat phase response, and accurate transient response is achieved without sacrificing attenuation of alias signals. The small delay through the wide transition band filters assures accurate matching of channel phasing for stereo applications.

### Diagnostics

118-AS operation is monitored by internal diagnostic circuits. Input signal level, A-D operation, memory, and power supplies are continuously checked. In addition, the microprocessor exercises an extensive set of digital power up diagnostics. Whenever a fault with the input signal or the 118-AS is detected, the front panel System Status LED flashes. For more detailed status information, diagnostic LEDs are provided on the circuit board modules.

### Service

Repair of the 118-AS is simplified by modular construction. All modular assemblies are easily accessible without removing the 118-AS from the equipment rack.

In addition to the standard service programs, Priority Module Exchange Service is available for the 118-AS. This program provides quick response when downtime is critical.

## CHARACTERISTICS

(For active balanced input)

**Channels** — 1 standard, expandable to 3 channels.

**Delay** — 10 fields total (user expandable to 40 fields). Automatic and manual delay control.

**Encoding** — 18-Bit floating point code.

**Sample Rate** — 93.75 kHz.

**Total Dynamic Range** — 100 dB.

**Peak Input Signal** — +24 dBm into 600 Ω, configurable to other levels.

**Gain** — Fixed at unity gain with provision for variable gain.

**Gain Accuracy** — ±0.2 dB at unity gain.

**Frequency Response** — ±0.2 dB, 50 Hz to 15 kHz, ±0.5 dB, 20 Hz to 20 kHz.

**Phase Accuracy** — Channels Match Within: ±1° at 1 kHz, ±10° at 10 kHz.

**Harmonic Distortion** — 0.05% maximum, 0 dBm to +24 dBm, 20 Hz to 20 kHz.

**IM Distortion** — 0.08% maximum, 0 dBm to +24 dBm, 20 Hz to 20 kHz.

**Signal to Noise Ratio** — 75 dB, 0 dBm to +24 dBm, 20 Hz to 20 kHz.

**Channel Separation** — 80 dB.

**Input Impedance** — High impedance balanced input, configurable to 150 Ω or 600 Ω.

**Input Coupling** — Active balanced input, can be configured for transformer coupling.

**Output Impedance** — Low impedance to drive 150 Ω or greater.

### POWER REQUIREMENTS

90 V to 132 V or 180 V to 250 V switchable. Fused 1.6 A (0.8 A for 220 V) on power supply and 5 A on rear panel. 80 W typical power for 3 channels.

### ENVIRONMENTAL CHARACTERISTICS

**Temperature** — Operating: 0°C to +50°C. Storage: −40°C to +65°C.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 483 | 19.0 |
| Height | 88 | 3.5 |
| Depth | 488 | 19.2 |
| **Weights** | **kg** | **lb** |
| Net | 11.6 | 25.6 |

**Audio Synchronizer Control Functions** — 118-AS Front Panel: Power LED; System Status LED.

**Controls and Indicators behind front panel** — Power Switch; Fuse; Line Voltage Selector; Bypass Switch and LED; Input Clip LED; Dead Output LED; Digital Diagnostics; Manual Delay Switches; Zero Remote Delay Switches; Auto Delay Disable Switch; Processor Reset Switch.

**Remote Control Functions** — System Status LED; Input Clip LED; Bypass Switch and LED; Delay Readout; Fields or mSec Switch and LEDs; Manual, Auto, or Total Switch and LEDs; Manual Delay Set Switches; Auto Delay Disable Switch and LED.

### INCLUDED ACCESSORIES

Instruction Manual, Power Cord, Rack Slides, Remote Control Mating Connector.

## ORDERING INFORMATION

When ordering, please use the exact nomenclature given here.

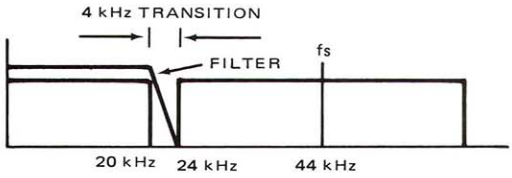
**118-AS** — Single Channel Audio Synchronizer ..... **$6,500**

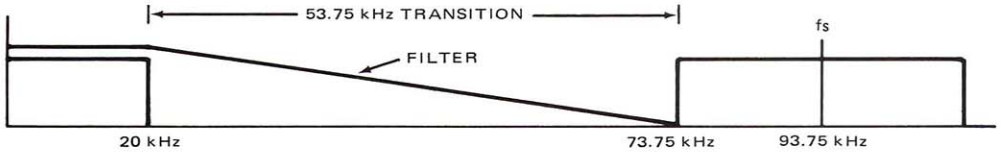
**118-F01** — Kit to Add One Additional Audio Channel ..... **$2,700**

**118-RC** — Remote Control Unit ..... **$1,400**

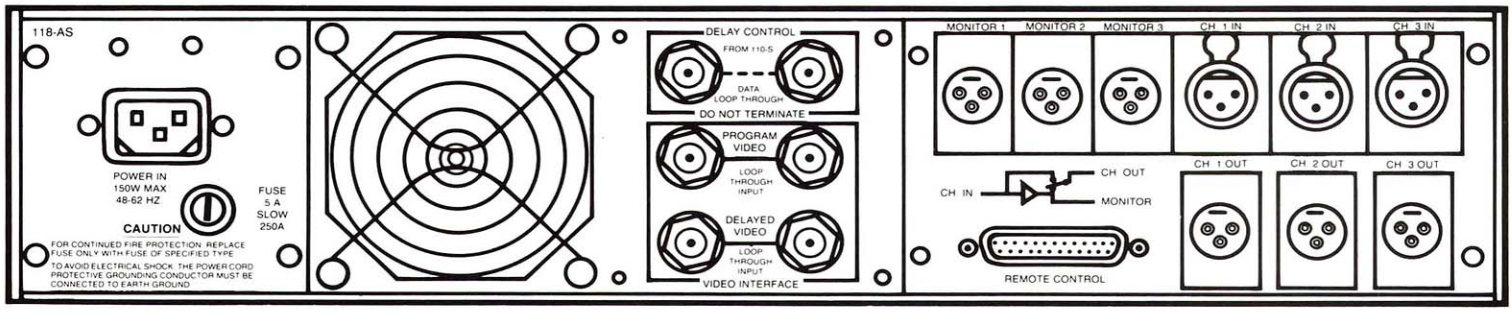
### OPTIONAL ACCESSORIES

Circuit Board Extender. (Same as 110-S Extender.) Order 670-7754-00 ..... **$440**



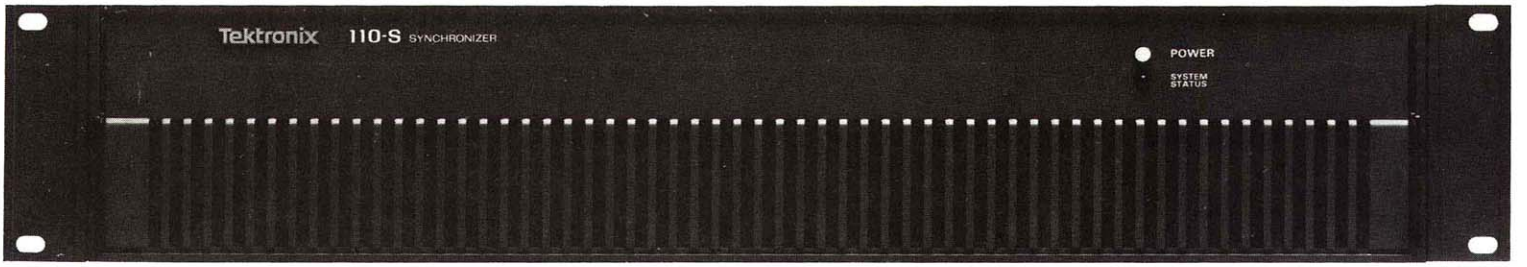




*Anti-aliasing filter responses for low and high sampling frequencies.*




*118-AS Rear Panel*

AUDIO SYNCHRONIZER




## 110-S

**True 10-Bit Accuracy and Resolution**

**Tracks Signals into the Noise**

**Optional Four-Field Memory for the Highest Picture Quality**

**Adaptive Decoding-Minimizes Picture Shifts while Preserving Horizontal and Vertical Detail, Provides Exceptionally High Quality Picture Freeze**

**Adaptive Clamping-Minimizes Streaking on Noisy Signals**

**Digitally Precise RS-170A Sync and Burst Insertion**

**Passes the Vertical Interval**

**Processing Amplifier**

**Precalibrated Boards in Modular Design**

The 110-S Synchronizer is a high quality 10-bit, 4 X fsc video synchronizer. The 10-bit architecture, adaptive decoding, and adaptive clamping combine to provide a synchronizer that performs well on noisy signals, minimizes horizontal picture shifts, and is virtually transparent to the processed signal.

### 10-Bit Precision

A Tektronix-designed 10-bit digitizer and a sampling rate of four times the subcarrier frequency result in negligible quantizing errors, low differential gain and phase, and a flat frequency response. Compared to 8-bit synchronizers, the 110-S has four times the accuracy and resolution. The resulting transparency to the video signal allows cascading of 110-S synchronizers in the signal path with minimum signal degradation.

### Tracking Into Noise

When noise from a fading ENG microwave feed or static interference degrades the S/N ratio, the 110-S will continue to track the signal. If the original sync and burst are clean, they may be passed with the original signal. Noisy sync and burst are replaced with precise, digitally-generated RS-170A sync and burst. The 110-S can be configured to track into the noise, freeze field, or go to black upon loss of the incoming signal. As noise increases, an adaptive clamp slows down to prevent horizontal streaking. Yet the clamp still responds quickly to hot switches.

### Four-Field Memory (Optional)

Four-field memory allows display of full color-frames with correct SCH phase and without decoder artifacts. Four-field storage also enables accurate synchronization without the 140 ns horizontal shift caused by frame overlapping. Freeze frames of one, two, or for maximum resolution, four fields may be selected with the 110-S four-field option.

### Adaptive Signal Decoding

Correct color framing on the standard, two-field memory 110-S is maintained with an adaptive comb/notch decoder. Vertical correlation of the picture information (for example a flag pole) allows chrominance/luminance separation to be done by a 3-line comb filter, thus preserving the fine detail in the picture. Absence of vertical correlation in the picture causes the notch decoder to be activated, thus preserving vertical chroma resolution. On the two-field version of the 110-S, the adaptive decoder eliminates the 140 ns horizontal shift.

### Processing Amplifier With Remote Control

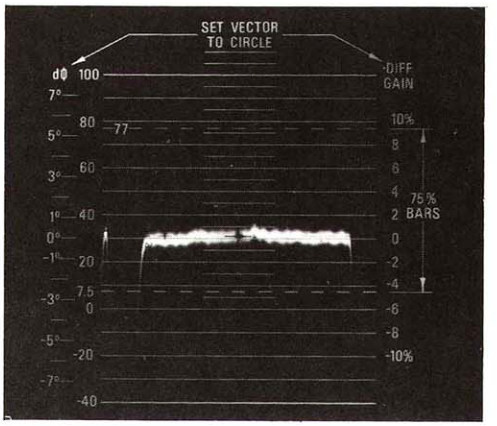
The 110-S processing amplifier provides adjustment of video gain, setup, chroma gain, and hue. Adjustment may be made with internal controls or via a rear panel remote control connector with externally supplied control voltages. The processing amplifier controls are located in the output circuitry and are active in both normal and freeze frame operation. The proc amp controls are included on the 110-RC Remote Control Unit.

### Digital Test Ports

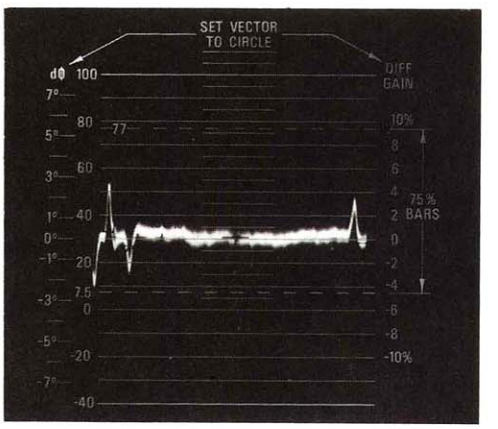
A Digital Test input port allows use of a digital signal from any of the Tektronix 1900 Series test signal generators to test the decoder and digital-to-analog converter. A Digital Output port enables analysis of the input video signal after it has been digitized by the analog-to-digital converter and processed through memory. This data can drive the DAC in a 1900 Series generator.

### Reliable Operation

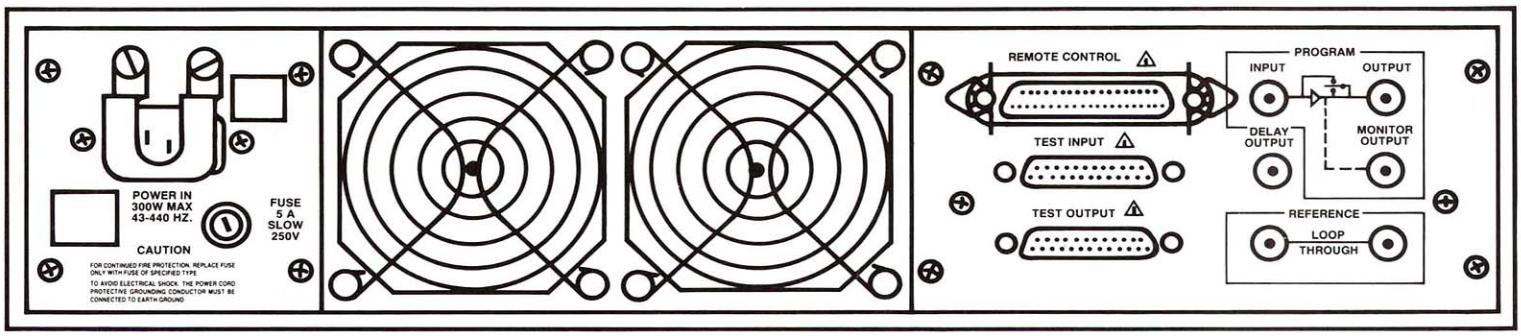
110-S reliability is assured by using high quality components, preconditioned IC's and two-piece connectors. Dual adaptive cooling fans provide overheating protection. The infrequent task of troubleshooting becomes fast and simple with modular, front-panel loaded circuitry designed so that the 110-S can be repaired without removing it from the rack. Factory precalibration of boards allows them to be replaced without disturbing the calibration of the synchronizer. Built-in diagnostics and input signal condition monitors continually check system status indicating possible problems. Memory error concealment allows in-service compensation of a memory fault, with remaining accuracy and resolution still better than 8-bit synchronizers. The 110-S automatically bypasses the signal when line power is lost.



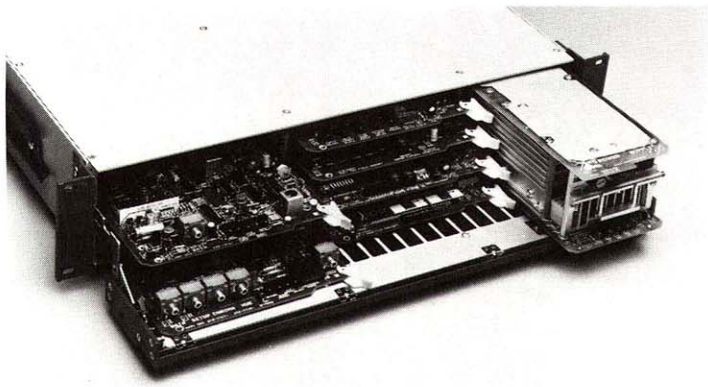

*110-S Differential Gain*

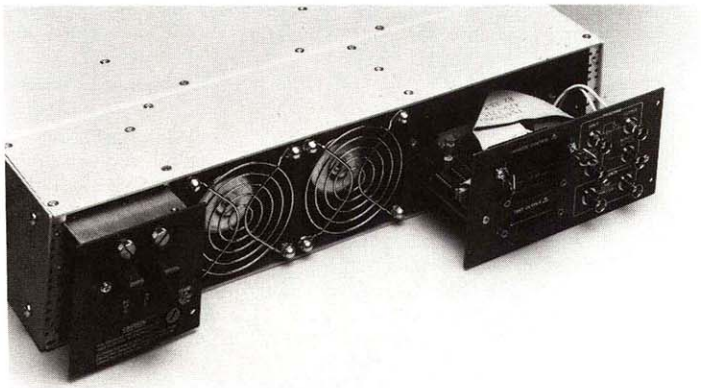



*110-S Differential Phase*




*110-S Rear Panel*





*Modular construction and board exchange speed repair and minimize down time.*

## Audio Delay

An Audio Delay control port allows automatic audio-video delay correction when used with a Tektronix 118-AS Audio Synchronizer.

## Quantizing Error Included in Specifications

The industry has neglected the effects of quantizing error on synchronizer product specifications. The following 110-S specifications, however, include quantizing error for a modulated ramp with 40 IRE subcarrier.

## CHARACTERISTICS

**Digital Sampling** — 10 bits at 14.3 MHz (1024 levels at 4 times NTSC Subcarrier).

### ELECTRICAL

#### PROGRAM CHANNEL

**Gain** — Program Output: Unity ±1%.

**Frequency Response** — ±1% to 4.2 MHz.

**Signal to Noise Ratio** — >60 dB unweighted.

**Chrominance/Luminance Gain Error** — <1%.

**Chrominance/Luminance Delay Error** — <10 ns.

**Differential Gain** — <1%.

**Differential Phase** — <1°.

**2T Pulse K Factor** — 0.5%.

**2T Pulse to Bar Ratio Error** — <1%.

**Short Time Distortion** — <1%.

**Line Time Distortion** — <0.5%.

**Field Time Distortion** — <0.5%.

#### PROCESSING AMPLIFIER

**Input Gain Range** — ±3 dB.

**Output Gain Range** — ±3 dB.

**Setup Range** — ±10 IRE.

**Hue Adjustment Range** — ±20°.

**Chrominance Gain Range** — ±3 dB.

**Signal Correction Timing** — Horizontal Blanking: 10.2 μs, 10.7 μs or 10.9 μs (selectable). Vertical Blanking: Start of field through line 21.

**Sync and Burst Insertion Timing** — Horizontal Insertion: 10.2 μs, 10.7 μs or 10.9 μs (selectable). Vertical Insertion: Start of field through line 9.

**Sync and Burst Insertion Amplitude Accuracy** — ±1 IRE.

**VITS Deletion Timing** — Vertical Timing: Line 10 through line 14 (selectable).

#### ADAPTIVE CLAMP

The adaptive clamp has 32 dB hum rejection in the absence of noise other than hum, and reduces hum rejection in the presence of other noise in order to minimize clamp streaking.

**Clamp Speed** — Slow: (<20 dB S/N)*1. Settling Time: Within 5 IRE in 30 lines or more. Medium: (<35 dB S/N)*1. Settling Time: Within 5 IRE in 10 lines to 30 lines. Fast: (>35 dB S/N)*1. Settling Time: Within 5 IRE in 2 lines to 3 lines.

*1 Approximate signal to noise ratio.

#### CHROMINANCE DECODER

**Video Signal Filtering Modes** — Pass: Signal unaltered. Comb: Chrominance inverted using 3-line comb filter. Burst is comb decoded. Notch: Chrominance inverted using 9-point transversal notch filter. VITS are notch decoded. Adaptive: Chrominance inverted using combination of notch and comb filters.

#### SYNCHRONIZER TIMING

**Output Timing Range** — Horizontal: 13.41 μs advance to 4.40 μs delay. Vertical: Two lines advance to one line delay.

#### POWER SUPPLY

**Line Voltage Range** — 90 V ac to 132 V ac; 180 V ac to 250 V ac.

**Peak Input Power** — 300 W maximum.

**Typical Power** — 240 W.

#### ENVIRONMENTAL CHARACTERISTICS

**Temperature** — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 480 | 19.0 |
| Height | 89 | 3.5 |
| Depth | 510 | 20.1 |
| Depth (Rackmount) | 491 | 19.4 |
| **Weight** | **kg** | **lb** |
| Net | 32.7 | 14.8 |

**Remote Control Interface Functions** — Remote Bypass, Manual Freeze, Freeze Field or Frame, Freeze Four Field, Enable Auto Freeze, Inhibit Decode, Inhibit Sync and Burst Insertion, External Test Data Enable, (Digital Input Port), Status Indicator, Power LED, System Status LED, Proc Amp Active LED, Bypass LED, Hue Control, Setup Level, Chroma Level, Input Gain (ADC), Output Gain (DAC).

#### INCLUDED ACCESSORIES

Power Cord (161-0066-00); remote plug 36-pin unwired connector with shell (131-0293-00); one set of rack slides (351-0636-00); circuit board extender (670-7754-00); operators manual; service manual.

## ORDERING INFORMATION

**110-S** Synchronizer ..... **$14,975**

**Option 10** — Four-Field Memory Adaptive Decoder . **+$4,200**

**110-RC** Remote Control Unit ..... **$500**

#### OPTIONAL ACCESSORY

**Spare Parts Kit** — Order 020-0990-00 ..... **$1,255**

**See page 146.**

NEW

## 110-S

**Heterodyne Color Processing**

**Auto VTR Signal Recognition**

**Infinite Window Correction Range**

The 110-S TBC option adds time base correction for heterodyne color VTR's to the 110-S Synchronizer. In addition to time base correction, the 110-S Synchronizer/TBC includes the benefits found in the standard 110-S Synchronizer, such as tracking noisy signals while maintaining picture continuity without breakup or streaking. With the four-field memory option, the 110-S maintains proper color framing without decoder artifacts or picture shifts. For more information on 110-S features and specifications see preceding two pages.

### Auto VTR Signal Recognition

The Auto VTR Signal recognition feature allows the 110-S Synchronizer/TBC to recognize a heterodyne color VTR signal and activate the TBC function. If automatic operation is not desired, the user can force the TBC to operate continuously. When the TBC mode is manually disabled or the input signal has no time base error, the 110-S functions as a standard synchronizer.

### Infinite Window Correction Range

With a standard memory capacity of two fields, the 110-S Synchronizer/TBC provides time base correction without feedback to the VTR. This permits time base correction of remote location VTR feeds as well as backup TBC capability for studio VTR sources.

### ELECTRICAL CHARACTERISTICS

**Program Channel: TBC Operating** — Meets all standard 110-S specifications except as listed below. Specifications reflect performance with a test signal generator input.

**Frequency Response** — Luminance: −3 dB at 2 MHz. Chrominance: −3 dB at ±600 kHz from 3.58 MHz.

**Signal to Noise Ratio** — >52 dB unweighted.

**Differential Gain** — 2% maximum.

**Differential Phase** — 2° maximum.

**2T Pulse K Factor** — Symmetrical with 5% ringing.

**Output Jitter** — Luminance: 20 ns maximum. Chrominance: 2° maximum.

**Program Channel: TBC Off** — Meets standard 110-S specifications.

**TBC Remote Control Interface Functions:** TBC On/Off; Enable Auto VTR Signal Recognition; Forced Heterodyne Processing.

### ORDERING INFORMATION

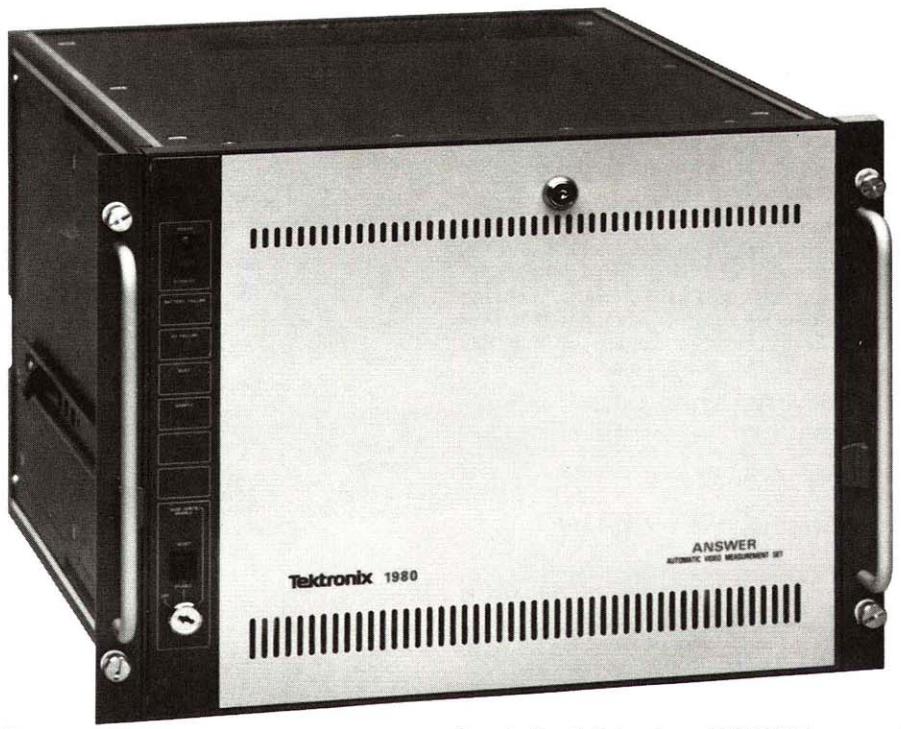
When ordering, please use the exact nomenclature given here.

**110-S** — Two fields of memory, adaptive decoder ..... **$14,975**

**Option 10** — Four fields of memory, adaptive decoder ..... **+$4,200**

**Option 20** — TBC..... **+$2,000**

**110F01** — TBC Retrofit Kit..... **$2,000**




## 1980 ANSWER

**Complete Video Measurement Capability**

**Waveform Digitizer to Capture Video Signal**

**ANSWER BASIC Software for Measurements, Analysis and Report Generation**

**Remote Terminal Capability**

The 1980 ANSWER Automatic Video Measurement Set provides total video measurement capabilities and offers maximum versatility and testing power. Special features provide quality measurement performance for a wide variety of applications.

### Programmability

The 1980 can be programmed using ANSWER BASIC to make specific measurements required for a wide range of video applications. Comprehensive software packages (Options 01, 04, 05 and 06) are available from Tektronix. The instrument can be tailored for a specific operation, automatically performing a single measurement or a group of measurements continuously, on operator demand, or at prescheduled times. The results can be returned in report format, with or without graphics, on a variety of terminals and printers. ANSWER's microprocessor control and ROM memory give you extensive flexibility. Format or standard changes can be made without the expensive modifications or recalibrations associated with analog test equipment.

### High Measurement Accuracy

The 1980 provides consistent measurement accuracy with high repeatability. Special features like signal offset, gain control, dither generation, and signal averaging can be used to minimize possible errors. Using these features can significantly reduce noise on the incoming signal and provide an effective resolution of 11 bits. This means you can use the 1980 for the most stringent measurement problems and have fast accurate results.

Due to its digital nature ANSWER has very few internal adjustments, providing a high degree of reliability over long periods of time.

### Amplitude, Phase and Timing Measurement

All type of measurements can be programmed into the 1980, including sync, burst, and bar amplitudes, differential gain and phase, and timing measurements. The 1980 can tell you immediately if video signals are within acceptable or legal limits.

### Remote Operation

The 1980 can also be operated from a remote terminal over telephone lines. With Option 12 (Autocall), it can even be programmed to automatically telephone a remote terminal under user specified conditions, e.g., an out-of-limits signal. The 1980 can be used in a wide range of applications including unattended and remote transmission systems, and systems under computer control.

### Display Terminal

ANSWER requires the use of a terminal for display. We offer several, including the 4105 and 4107 13 inch Color Graphics terminals. Standard RS-232C interfaces ensure compatibility with a wide range of other terminals and printers.

### Available Measurement Programs

Application programs taking full advantage of the 1980's capabilities can be purchased from Tektronix to make most NTSC and PAL video broadcast measurements.

The flexibility of software-based measurements, unavailable in analog instruments, means that the 1980 can be tailored to a wide range of applications for the analysis, measurement, and testing of baseband video signals.

### RS-232C Compatibility

ANSWER has five RS-232C (ASCII coding) Ports. This means the instrument can be adapted to a wide range of applications, including unattended and remote systems and computer control.

## CHARACTERISTICS

### SIGNAL HANDLING

**Inputs** — A and B (user selectable).

**Impedance** — 75 Ω.

**Return Loss** — Video: ⩾46 dB to 5 MHz.

**Signal Level** — 0.5 V to 2 V p-p; sync negative.

**Coupling** — Dc or ac nonfloating (user selectable).

**Clamp** — Selection: Fast, slow, or off (user selectable). Level: Sync tip or back porch.

**Hum Rejection** — Fast: >36 dB. Slow: <1 dB.

**Signal Averaging** — Noise Reduction: 15 dB; with 32 line averaging and incoming signal-to-noise ratio of 46 dB or less. Dynamic Range: 2.5 V maximum; with 0 offset. Gain Range: 0 times to 15.5 times in 0.5 increments. Offset Range: 0 LSB to 248 LSB ±0.5 LSB (8 LSB increments); referred to input at unity gain. Noise Floor: −72 dB (0 dB = 714 mV).

**Distortions** — Differential Gain Error: ⩽0.5%. Differential Phase Error: ⩽0.4°. Luminance Nonlinearity Error: ⩽1.0%. Amplitude/Frequency Error (0 MHz to 5 MHz): 0 dB ±0.25 dB; 7.16 MHz = ⩾−46 dB. Delay/Frequency Error (0 MHz to 5 MHz): ⩽20 ns.

### SYNCHRONIZATION

**Modes** — Internal: Satisfactory operation with 26 dB signal-to-noise ratio (Sound-in-Syncs disabled). Channel A and B (user selectable). External: Channel A and B (user selectable).

**Amplitudes** — Internal Mode: 143 mV (20 IRE) minimum; negative going sync on incoming signal. External Mode: Minimum: 0.2 V p-p into 75 Ω, composite sync. Maximum: 8.0 V p-p into 75 Ω, composite sync.

### ANALOG TO DIGITAL CONVERSION

**Resolution** — 8 bits; 11 bits effective with dither.

**Accuracy** — RMS: ±0.25 LSB (±0.1%). Peak: ±0.5 LSB (±0.2%).

**Conversion Rate** — 20 MHz maximum.

**Monotonicity** — All 256 codes present and in sequence with no polarity reversals.

**Sampling Rate** — NTSC: 910 x horizontal frequency. PAL: 1135 x horizontal frequency.

*Note: User selectable means that the function is controlled from the keyboard.*

### DIGITAL PROCESSING

**Signal Memory** — Video Acquisition Memory Capacity: 32 k samples. Video Acquisition Memory Controller Sampling Modes: Line rate, field rate or block sampling between two points on signal. Save Value: Multiples of eight. Skip Value: Multiples of two. Picture Monitor Bright-Up Pulse Output: Amplitude: ≈240 mV. Termination: Internal in 75 Ω.

**Real Time Clock** — Internal Reference Stability: 10 P/M total over +10°C to +50°C; crystal controlled. External Input Frequency: 1 MHz. External Input Amplitude: 0.3 V to 4.0 V.

**Microcomputer** — User Memory: 32 k words. Nonvolatile Memory: 8 k words.

**Software Control** — TEK ANSWER BASIC.

### DIGITAL INTERFACE

**Access Ports** — Interface: RS-232C; (ASCII code). Number: 5; 3 DCE*1 (full duplex). 2 DTE*2 (full duplex).

**Baud Rate** — Five Ports: Up to 9600; user programmable.

**Automatic Call-Up** — RS-366 (optional).

**User Operation** — Via keyboard (ASCII).

**1 DCE = Data Communication Equipment*

**2 DTE = Data Terminal Equipment*

### ENVIRONMENTAL CHARACTERISTICS

**Temperature Range** — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Altitude Range** — Operating: Sea level to 4572 m (15,000 ft). Nonoperating: Sea level to 15 240 m (50,000 ft).

### PHYSICAL CHARACTERISTICS

| | Cabinet | | Rackmount | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 429 | 16.9 | 483 | 19.0 |
| Height | 355 | 14.0 | 355 | 14.0 |
| Depth | 593 | 24.0 | 644 | 22.0 |
| **Weights** ≈ | **kg** | **lb** | **kg** | **lb** |
| Net | 25.0 | 55.0 | | |

### INCLUDED ACCESSORIES

Left rackmounting adaptor (367-0279-00); right rackmounting adaptor (367-0280-00); tracks (351-0104-03); 15 ft RS-232C modem connecting cable (012-0939-00); rubber cabinet feet (348-0068-00); power cord (161-0066-01); rack slides (351-0623-00); manual.

## 1980 ANSWER Option 01 Applications Software

- Unattended Monitoring of NTSC Video Signals
- Most RS-170A, NTC-7, and FCC Measurements
- Waveform Plots For Analysis and Documentation
- Remote Operation
- Automatic Logging
- User Definable Measurement Limits
- Manual Measurements
- NTC-7 Out-Of-Service Measurements
- Vertical Interval Autoscan for Automatic Test Signal Locations
- Video Switch for Multisource Capability

With the Option 01 NTSC Applications Software, ANSWER makes automatic or operator-initiated measurements on VITS and full field signals. Amplitude, phase, and timing parameters can all be determined quickly and accurately.

### Unattended Monitoring

The 1980 ANSWER Option 01 can continuously monitor video signals, make standard measurements, compare them against user-defined limits, and print alarm messages should these limits be exceeded.

### RS-170A, NTC-7, and FCC Measurements

Option 01 will make RS-170A and FCC timing measurements, as well as amplitude and phase measurements on both NTC-7 and FCC VITS.

### Waveform Plots

Waveforms can be plotted on local or remote graphics devices for further analysis. Any portion of the waveform can be expanded to fill the screen and examine small distortions in detail. Hard copies of the waveform plots are useful for support documentation and trend analysis.

### Remote Operation

The Option 01 Program can be operated from a remote terminal over voice-grade telephone lines. With Option 12 (Auto-Call) it will automatically dial up a remote terminal under user specified conditions e.g., an out-of-limits signal.

### Automatic Logging

A user-defined set of measurements will automatically be made and the results printed at operator-scheduled times.

### User-Definable Measurement Limits

The user can specify inner (caution) and outer (alarm) limits for each measurement parameter, and different sets of limits for the two 1980 video input channels.

### Manual Measurements

In the manual mode, one or more individual measurements can be made either once or repeatedly. The numeric results are printed. Combined with the capability to plot waveforms, this makes ANSWER a powerful troubleshooting instrument.

### NTC-7 Out-Of-Service Measurements

Field time distortion, long time distortion and dynamic gain distortion are all made as specified in NTC Report 7.

### Vertical Interval Auto-Scan

Standard test signals within the vertical interval are automatically located and the appropriate locations used during sampling.

### Video Switch

Several video sources can be specified and the program will make complete sets of measurements sequentially on each of them. With an RS-232 controllable switcher and insertion of a few extra lines of code, the system will automatically switch in the correct video source.

## CHARACTERISTICS, OPTION 01

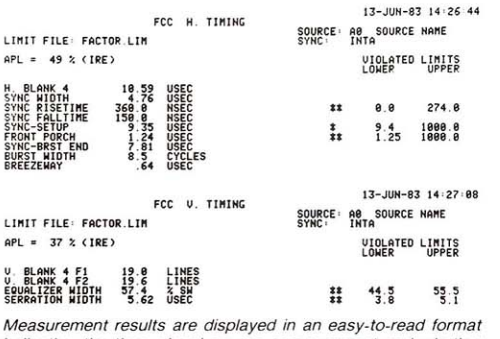
The measurement specifications cited in this section are valid only within the following environmental limits: Temperature range to 0°C to +50°C, with a minimum warm-up time of 20 minutes.

The following listing gives each measurement and its associated range and accuracy.

All measurement accuracies specified are valid over the entire dynamic range, with an unweighted signal-to-noise ratio of at least 46 dB on the incoming signal.

**AMPLITUDE AND PHASE MEASUREMENTS**

| Measurement | Range | Accuracy |
|---|---|---|
| Bar Amplitude | 30 IRE to 130 IRE units | ±0.5 IRE |
| Sync Amplitude | 20 IRE to 80 IRE units | ±0.5 IRE |
| Burst Amplitude | 10 IRE to 90 IRE units | ±0.5 IRE |
| Average Picture Level | −20% +120% of 100 IRE | ±3% |
| Reference Black Level | −20 IRE to 130 IRE units | ±0.5 IRE |
| Line Time Distortion | 0% to 40% | ±0.5% |
| Pulse to Bar Ratio | 10% to125% | ±0.5% |
| 2T Step Ringing | 0% to 25% | ±2% |
| Relative Chroma Gain | 25% to 175% | ±0.5% |
| Relative Chroma Time | ±300 ns | ±10 ns |
| Amplitude/ Frequency | 0 IRE to 120 IRE | ±1 IRE or ±2% whichever is greater |
| Luminance Nonlinearity | 0% to 50% | ±0.5% |
| Chrominance Nonlinear Gain | 20 IRE Chroma 5 IRE to 35 IRE 80 IRE Chroma 45 IRE to 160/ | ±0.5 IRE |
| Chrominance Nonlinear Phase | 0° to 180° | ±1° |
| Differential Gain | 0% to 180% | ±0.4% |
| Differential Phase | 0% to 100% | ±0.5% |
| Chrominance Luminance Intermodulation | 0 IRE to 50 IRE | ±0.5 IRE |
| Signal to Noise Ratio | 26 dB to 72 dB | within 1 dB |
| Low Frequency Periodic Noise<br>Relative Burst Gain | 0 dB to 60 dB<br>±50% | within 1 dB<br>±0.5% |
| Relative Burst Phase | ±180° | ±0.4° |




*Measurement results are displayed in an easy-to-read format indicating the time, signal source, measurement and whether the measured value exceeded caution (*) or alarm (**) limits.*

**OUT-OF-SERVICE MEASUREMENTS**

| Measurement | Range | Accuracy |
|---|---|---|
| Field Time Distortion | 0% to 40% | ±0.5% |
| Long Time Distortion | Overshoot Range:<br>20 IRE to 100 IRE<br>0 IRE to 20 IRE<br>Settling Time:<br>0.1 s to 30 s | ±1.0 IRE<br>±0.5 IRE<br>±2% of bounce rate |
| Dynamic Gain Distortion | Picture Gain: ±25%<br>Sync Gain ±25% | ±1.0 IRE<br>±1.0 IRE |

**WITH ZERO-CARRIER PULSE PRESENT**

| Measurement | Range | Accuracy |
|---|---|---|
| Blanking Level | 65% to 85% of max carrier | ±0.5% |
| Reference White Level | 2.5% to 22.5% of max carrier | ±0.5% |

**FCC AND RS-170A TIMING MEASUREMENTS**

| Measurement | Range | Accuracy |
|---|---|---|
| H Sync Width | 1 μs to 8 μs | ±25 ns |
| Front Porch Duration | 0.5 μs to 2 μs | ±25 ns |
| Sync to Start of Video Duration | 8 μs to 15 μs | ±25 ns |
| Sync to Burst Start Duration | 4 to 30 cycles | ±20° |
| Sync to End of Burst<br>Duration | 6 μs to 15 μs | ±20 ns<br>±0.05 burst cycle |
| H Blanking Width | 8 μs to 30 μs | ±50 ns |
| Color Burst Width | 6 to 13 cycles | ±1 cycle amplitude detection<br>±0.5 IRE |
| Breezway Width | −2.0 μs to 3.5 μs | ±25 ns<br>±0.5 burst cycle |
| H Sync Rise and Falltimes | 0.14 μs to 0.3 μs<br>0.31 μs to 1.0 μs | ±20 ns<br>±30 ns |
| Equalizing Pulse Width | 1 μs to 20 μs | ±25 ns |
| Serration Width | 1 μs to 20 μs | ±25 ns |
| Vertical Blanking Width | 20 to 50 lines | ±140 ns |

The Option 01 program is stored in PROMS on two circuit boards which plug into the 1980 base unit.

## 1980 ANSWER Option 04
### NTSC Monitoring Software

**Unattended Monitoring of NTSC Video Signals from Studios, STLs, Earth Stations, and Transmitters**

**Full Spectrum of RS-170A, NTC-7, and FCC Measurements**

**Waveform Plots For Analysis and Documentation**

**Remote Operation**

**Automatic Logging**

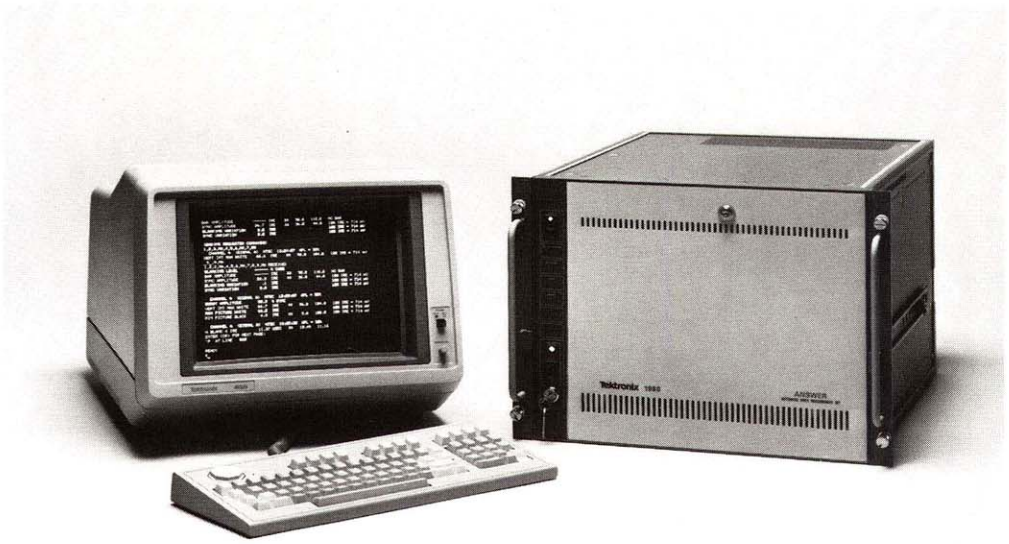
**User Definable Measurement Limits**

**Operator-Initiated Individual Measurements**

**VIRS Measurements**

**Vertical Interval Scan for Test Signal Locations**

**User-Defined Measurement Groups**

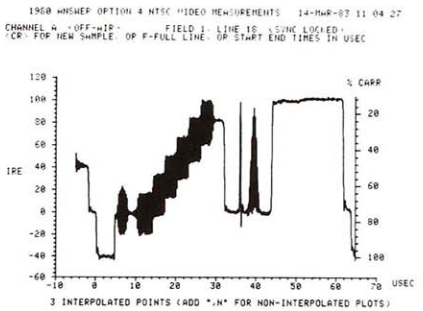


With the Option 04 NTSC Video Signal Monitoring Software, ANSWER makes automatic or operator-initiated measurements on VITS and full field signals. Amplitude, phase, and timing parameters can all be determined quickly and accurately.

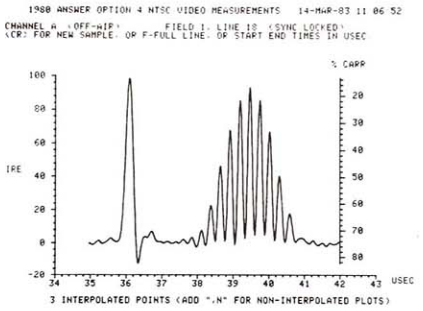
**Unattended Monitoring**
The 1980 ANSWER Option 04 can continuously monitor video signals, make user-selected standard measurements, compare them against user-defined limits, and print alarm messages should these limits be exceeded.

**RS-170A, NTC-7, and FCC Measurements**
Option 04 will make RS-170A and FCC timing measurements, as well as amplitude and phase measurements on both NTC-7 and FCC VITS. Amplitude measurements are reported as % of carrier, % of bar, or IRE units. This broad spectrum of measurement capability makes the Option 04 useful in many different video environments: at transmitters, in studios, at cable head-ends, at satellite earth stations and with TV equipment manufacturers.

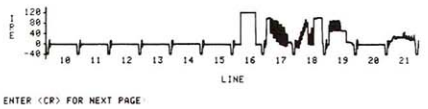
**Waveform Plots**
Waveforms can be plotted on local or remote graphics devices for further analysis. Any portion of the waveform can be expanded to fill the screen and examine small distortions in detail. Hard copies of the waveform plots are useful for support documentation and trend analysis.




*Any line of video can be graphed on graphic display terminals and hard-copy devices locally, or at remote locations.*




*Any portion of a line can be expanded for detailed analysis.*




*Waveform on lines 10 through 21 can be graphed for quick visual recognition of vertical interval line usage.*

**Remote Operation**
The Option 04 Program can be operated from a remote terminal over voice-grade telephone lines. With Option 12 (Auto-Call). It will automatically dial up a remote terminal under user specified conditions e.g., an out-of-limits signal.

**Automatic Logging**
A user-defined set of measurements will automatically be made and the results printed at operator scheduled times.

**User-Definable Measurement Limits**
The user can specify inner (caution) and outer (alarm) limits for each measurement parameter, and different sets of limits for the two 1980 video input channels.

**Operator-Initiated Individual Measurements**
Monitoring can be interrupted at any time to make one or more individual measurements, once or repeatedly. The numeric results are printed. Combined with the capability to plot waveforms, this makes ANSWER a powerful troubleshooting instrument.

**VIRS Measurements**
The system will measure reference black (setup) level and chrominance phase relative to burst. These measurement results are especially sensitive indicators of the perceived quality of the signal of the "end-viewer" at a home receiver, which is the "bottom line" of video signal quality control.

**Scan the Vertical Interval for Test Signal Locations**
NTC-7 or FCC VITS and VIRS can be located by using the Option 04 Program to scan the vertical interval and "memorize" the field and line locations of these well-defined waveforms. The locations found are used in subsequent sampling. Also, the waveforms on lines 10 through 21 can be plotted, enabling the operator to visually locate the zero carrier pulse, digital data, or a quiet line.

**User-Specified Measurement Groups**
New commands can be created each of which "stands for" a sequence of Option 04 commands. This enables unique Option 04 command sequences to be developed which perform a measurement task that is tailor-made for the user's application. Thereafter, only the user-coined command name needs to be typed to initiate the series of measurements.

## CHARACTERISTICS, OPTION 04

The measurement specifications cited in this section are valid only within the following environmental limits: Temperature range of 0°C to 50°C with a minimum warm-up time of 20 minutes.

The listing below gives each measurement and its associated range and accuracy.

All measurement accuracies specified are valid over the entire dynamic range, with an unweighted signal-to-noise ratio of at least 46 dB on the incoming signal.

### HORIZONTAL INTERVAL TIMING MEASUREMENTS

| Measurement | Range | Accuracy |
|---|---|---|
| **Breezeway Width** | 0.2 μs to 3.5 μs | ±25 ns |
| **Color Burst Width** | 6 to 13 cycles | ±0.1 cycle |
| **Front Porch Duration** | 0.5 μs to 2 μs | ±25 ns |
| **Horizontal Blanking Width** | 6 μs to 30 μs | ±50 ns |
| **Horizontal Sync Risetime and Falltime** | 80 μs to 1 μs | ±30 ns |
| **Horizontal Sync Width** | 1 μs to 8 μs | ±25 ns |
| **SCH Phase** | ±90° | ±5° |
| **Sync to Setup** | 5 μs to 18 μs | ±25 ns |
| **Sync to Start-of-Burst** | 4 μs to 8 μs (i.e. 16 to 30 cycles) | ±140 ns (0.5 cycles) ±20 ns |
| **Sync to End of-Burst** | 6 μs to 15 μs | ±20 ns |

### VERTICAL INTERVAL TIMING MEASUREMENTS

| Measurement | Range | Accuracy |
|---|---|---|
| **Equalizing Pulse Width** | 25% to 200% of nominal horizontal sync pulse width | ±0.5% |
| **Serration Width** | 1 μs to 20 μs | ±25 ns |
| **Vertical Blanking Width** | 19 to 29 lines | −0.1 lines to +0.2 lines |

### FCC COLOR BAR MEASUREMENTS

| Measurement | Range | Accuracy |
|---|---|---|
| **Color Bar Amplitude Errors** | ±100% of nominal | ±1.0% or ±1.0 IRE, whichever is greater |
| **Color Bar Phase Errors** | ±180° from nominal | ±1° |
| **Color Bar Chrominance-Luminance Gain Ratio** | 0% to 200% of nominal | ±2% |

### AMPLITUDE AND PHASE MEASUREMENTS

| Measurement | Range | Accuracy |
|---|---|---|
| **Bar Amplitude** Zero Carrier Pulse Present | 0% to 90% of Carrier | ±0.4% |
| Zero Carrier Not Present | 0 IRE to 200 IRE | ±0.5 IRE |
| **Chrominance-Luminance Delay** | ±300 ns | ±20 ns |
| **Chrominance-Luminance Gain** | 0% to 160% | ±1% |
| **Differential Gain** | 0% to 100% | ±0.5% |
| **Differential Phase** | 0° to 360° | ±0.4° |
| **Luminance Non-linear Distortion** | 0% to 50% | ±1% |
| **Relative Burst Gain** | ±100% | ±0.5% |
| **Relative Burst Phase** | ±180° | ±0.4° |
| **Burst Amplitude** % of Sync | 25% to 200% of sync | ±1.3% of sync or ±0.5 IRE, whichever is greater |
| % of Bar | 10% to 80% of Bar | ±0.5% |
| Bar Not Present | 10 IRE to 80 IRE | ±0.5 IRE |
| **Sync Amplitude** | 20% to 80% of Bar | ±0.5% |
| Bar Not Present | 20 IRE to 80 IRE | ±0.5 IRE |
| **Blanking Level** | 0% to 90% of Max Carrier | ±0.5% |
| **Sync Variation** | 0% to 50% of Max Carrier | ±0.5% |
| Zero Carrier Not Present | 0% to 50% of Bar | ±0.5% |
| Zero Carrier & Bar not present | 0 IRE to 50 IRE | ±0.5 IRE |
| **Blanking Variation** | 0% to 50% of Max Carrier | ±0.5% |
| Zero Carrier Not Present | 0% to 50% of Bar | ±0.5% |
| Zero Carrier & Bar not present | 0 IRE to 50 IRE | ±0.5 IRE |
| **Vertical Interval White Level** | 0% to 90% of Max Carrier | ±1.0% |
| Zero Carrier Not Present | 0% to 100% of Bar | ±1.0% |
| Zero Carrier & Bar not present | 0 IRE to 100 IRE | ±1.0 IRE |
| **Maximum Picture White** | 0% to 90% of Max Carrier | ±1.0% |
| Zero Carrier of Bar Not Present | 0% to 100% | ±1.0% |
| Zero Carrier & Bar Not Present | 0 IRE to 100 IRE | ±1.0 IRE |
| **Minimum Picture Black** | −40% to +100% of Bar | ±1.0% |
| Bar Not Present | −40 IRE to +100 IRE | ±1.0 IRE |

### FREQUENCY RESPONSE MEASUREMENTS

| Measurement | Range | Accuracy |
|---|---|---|
| **Multiburst Flag Amplitude** | 0% to 90% of max Carrier | ±0.5% |
| Zero Carrier Not Present | 20% to 130% of Bar | ±0.5% |
| Zero Carrier & Bar Not Present | 20 IRE to 130 IRE | ±0.5 IRE |
| **Multiburst Packet Amplitudes (6 Results)** | 0% to 100% of Flag | ±3% |

### LINEAR WAVEFORM DISTORTION MEASUREMENTS

| Measurement | Range | Accuracy |
|---|---|---|
| **Line Time Distortion** | 0% to 40% of Bar | ±0.5% |
| **Pulse-to-Bar Ratio** | 10% to 125% | ±1% |
| **Short-Time Waveform Distortion** | 0% to 25% | ±1% |
| **Chrominance Nonlinear Gain Distortion** | 5 IRE to 35 IRE: 20 IRE chroma 45 IRE to 160 IRE: 80 IRE chroma | ±0.5 IRE |
| **Chrominance Nonlinear Phase Distortion** | 0° to 360° | ±1.0° |
| **Chrominance to Luminance Intermodulation** | ±50 IRE | ±0.5 IRE |

### VIRS MEASUREMENTS

| Measurement | Range | Accuracy |
|---|---|---|
| **VIRS Setup** Reference Black | −20% to 130% of Bar | ±0.5% |
| Bar Not Present | −20 IRE to 130 IRE | ±0.5 IRE |
| **VIRS Chrominance Reference Amplitude** | 0% to 200% of burst amplitude | ±1.0% |
| Burst Not Present | 0% to 80% of Bar | ±1.0% |
| Burst & Bar Not Present | 0 IRE to 80 IRE | ±1.0 IRE |
| **VIRS Chrominance Phase Relative to Burst** | ±180° | ±1.0° |
| **VIRS Luminance Reference** | 30% to 100% of Bar | ±1.0% |
| Bar Not Present | 30 IRE to 100 IRE | ±1.0 IRE |

### LOW FREQUENCY NOISE MEASUREMENT

| Measurement | Range | Accuracy |
|---|---|---|
| **Low Frequency SNR** | 26 dB to 60 dB | ±1.0 dB |

### SIGNAL-TO-NOISE RATIO MEASUREMENTS

| Measurement | Range | Accuracy |
|---|---|---|
| **Unweighted SNR** | 26 dB to 65 dB<br>66 dB to 72 dB | ±1.0 dB<br>±2.5 dB |
| **Luminance Weight SNR** | 26 dB to 72 dB | ±1.0 dB |
| **Chrominance Weighted SNR** | 26 dB to 72 dB | ±1.0 dB |

The Option 04 program is stored in PROMS on two circuit boards which plug into the 1980 base unit.

```
                ANSWER 1980 VIDEO MEASUREMENTS - REPORT LOG
27-APR-83 11:44.16                          VIOLATED LIMITS
                                             LOWER   UPPER

  CHAN A  (SIGNAL A)   11:44:16    APL =   41 %
LINE SYNC DURATION       4.63  USEC
SYNC RISE TIME         185.0   NSEC
SYNC FALL TIME         195.0   NSEC
SYNC AMPL ERROR          4.8   %
FRONT PORCH            ------  USEC    **        .5     3.0   NO BLANKING EDGE
LINE BLANKING          ------  USEC    **       9.1    16.0   NO BLANKING EDGE
BROAD PULSE SEP          4.7   USEC
EQUALISING PULSE         2.33  USEC    *        2.34    2.36
LINE SYNC-TO-BURST       5.61  USEC
BURST DURATION           2.24  USEC                             10 CYCLES
BURST AMPL ERROR         9.1   %       *       -3.0     3.0
BAR TILT                  .7   %
BAR RISE TIME          190.0   NSEC
BASELINE DISTORTN       -1.9   %       *       -1.0     1.0
2T PULSE/BAR ERROR     -16.5   %       *      -10.0    10.0
2T PULSE K FACTOR        1.1   % KF    *        0.0     1.0
LUM NON-LINEARITY        5.9   %       *        0.0     5.0
```

*Measurement results are displayed in an easy-to-read format indicating the time, signal source, measurement, whether the measured value exceeded caution (*) or alarm (**) limits, and whether the out-of-limits value is better (B) or worse(W) than the previously reported value. This same format is also used for reporting individual measurements when the operator interrupts the monitoring process.*

## 1980 ANSWER Option 05
## PAL Monitoring Software

**Unattended Monitoring of PAL Video Signals from Studios, STLs, Earth Stations, and Transmitters**

**Measurement of Signal Timing, Frequency Response, Amplitude, Phase, and Noise Parameters**

**Waveform Plots for Analysis and Documentation**

**Remote Operation**

**Automatic Logging**

**User Definable Measurement Limits**

**Operator-Initiated Individual Measurements**

**Vertical Interval Scan for Test Signal Locations**

**User-Defined Measurement Groups**

With the Option 05 PAL Video Signal Monitoring Software, ANSWER makes automatic or operator-initiated measurements on ITS and full field signals.

### Unattended Monitoring
Option 05 will continuously monitor video signals, make user-selected standard measurements, compare them against user-defined limits, and print alarm messages should these limits be exceeded.

### Signal Timing, Frequency Response, Amplitude, Phase, and Noise Measurements
The user can apply Option 05 in many different video environments: at transmitters, in studios, at cable head-ends in TV manufacturing facilities and at satellite earth stations. CCIR Rep. 624-1 timing measurements, as well as amplitude and phase measurements on CCIR Rec. 567 ITS, can be made with the amplitude measurement results reported as mV, % of bar, or % of carrier. Blanking level and baseline distortion can be measured and the amplitude/frequency response of various television circuits determined by measuring the amplitude of the first five multiburst frequency packets, referenced to the multiburst flag.

### Waveform Plots
Waveforms can be plotted on local or remote graphic devices for further analysis. Any portion of the waveform can be expanded to fill the screen and examine small distortions in detail. Hard copies of the waveform plots are useful for support documentation and trend analysis.

### Remote Operation
The Option 05 program can be operated from a remote terminal over voice grade telephone lines. With Option 12 (Autocall) it will automatically dial up a remote terminal under user-specified conditions e.g., an out-of-limits signal.

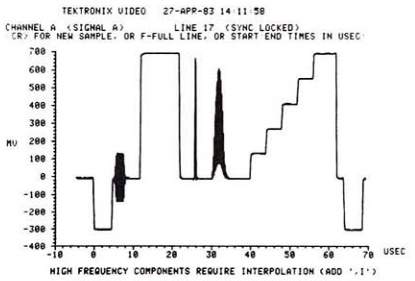
### Automatic Logging
A user-defined set of measurements will automatically be made and the results printed at operator-scheduled times.

### User-Definable Measurement Limits
The user can specify inner (caution) and outer (alarm) limits for each measurement parameter and different sets of limits for the two 1980 video input channels.

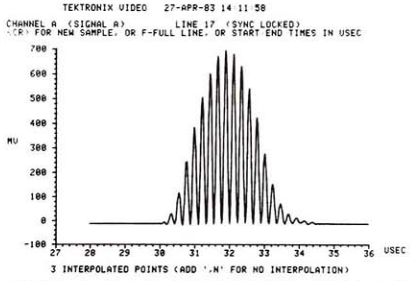
### Operator-Initiated Individual Measurements
Monitoring can be interrupted at any time to make one or more individual measurements, once or repeatedly. The numeric results are printed. Combined with the capability to plot waveforms, this makes ANSWER a powerful trouble-shooting instrument.

### Scan the Vertical Interval for Test Signal Locations
CCIR Rec. 567 ITS, EBU color bars, multiburst, Zero Carrier, teletext, or quiet lines can be located by using the Option 05 program to scan the vertical interval, and "memorize" the field and line locations of these well-defined waveforms. The locations found are used in subsequent sampling. Also, the waveforms on lines 9 through 23 and 322 through 336 can be plotted enabling the operator to visually locate the Zero-Carrier pulse, teletext, or a quiet line.

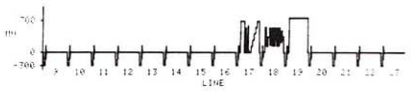
### User-Specified Measurement Groups
New commands can be created, each of which "stands for" a sequence of Option 05 commands. This enables unique Option 05 command sequences to be developed which perform a measurement task that is tailor-made for the user's application. Thereafter, only the user-coined command name needs to be typed to initiate the series of measurements.




*Any line of video can be graphed on graphic display terminals and hard-copy devices locally, or at remote locations*




*Any portion of a line can be expanded for detailed analysis*




*Waveforms on lines 9 through 23 (or 322 through 336) can be graphed for quick visual recognition of vertical interval line usage*

## CHARACTERISTICS

The measurement specifications cited in this section are valid only within the following environment limits: Temperature range of 0°C to 50°C, with a minimum warm-up time of 20 minutes. The following listing gives each measurement and its associated range and accuracy.

All measurement accuracies are valid over the entire dynamic range, and are specified for unweighted signal-to-noise ratios of both 46 dB and 60 dB on the incoming signal.

**LINE BLANKING TIMING MEASUREMENTS**

| Measurement | Range | Accuracy | |
|---|---|---|---|
| | | at 46 dB | at 60 dB |
| Color Burst Duration | 6 to 13 cycles | ±0.2 cycle | ±0.2 cycle |
| Front Porch Duration | 0.5 μs to 3 μs | ±30 ns | ±25 ns |
| Line Blanking | 9 μs to16 μs | ±40 ns | ±30 ns |
| Line Sync Rise and Falltimes | 0.14 μs to 0.3 μs<br>0.3 μs to 0.8 μs | ±20 ns<br>±40 ns | ±15 ns<br>±30 ns |
| Line Sync | 1.4 μs to 6.6 μs | ±20 ns | ±15 ns |
| Sync-to-Start of Burst | 2.2 μs to 8.0 μs | ±30 ns | ±20 ns |

**FIELD BLANKING TIMING MEASUREMENTS**

| Measurement | Range | Accuracy | |
|---|---|---|---|
| | | at 46 dB | at 60 dB |
| Equalizing Pulse Duration | 1.4 μs to 20 μs | ±25 ns | ±20 ns |
| Broad Pulse Separation | 1.4 μs to 20 μs | ±25 ns | ±20 ns |

**OTHER TIMING MEASUREMENTS**

| Measurement | Range | Accuracy | |
|---|---|---|---|
| | | at 46 dB | at 60 dB |
| Bar Risetime | 0.14 μs to 0.3 μs<br>0.3 μs to 1.0 μs | ±25 ns<br>±60 ns | ±15 ns<br>±20 ns |

**AMPLITUDE AND PHASE MEASUREMENTS**

| Measurement | Range | Accuracy | |
|---|---|---|---|
| | | at 46 dB | at 60 dB |
| Sync Amplitude Error | +100% to −50% | ±1.25% | ±1.0% |
| Sync Amplitude Error (with Sound-in-Sync) | +100% to −50% | ±1.25% | ±1.0% |
| Burst Amplitude Error | +80% to −50% | ±1.5% | ±1.4% |
| Chrominance Reference Amplitude Error | −80% to +50% | ±1.5% | ±1.25% |
| Luminance Bar Amplitude Error | +30% to −70% | ±0.75% | ±0.6% |
| Luminance Bar Amplitude | 200 to 900 mV | ±5.5 mV | ±4.5 mV |
| Bar Tilt Error | 0% to 40% | ±0.7% | ±0.4% |
| Blanking Level | 0% to 100% of Zero Carrier | ±1% | ±1% |
| 2T Pulse K-factor | 0% to 10% Kf | ±0.7% Kf | ±0.4% Kf |
| Chrominance-Luminance Gain Inequality | ±75% of bar amplitude | ±1.4% | ±1.2% |
| Chrominance-Luminance Delay Inequality | ±300 ns | ±35 ns | ±25 ns |
| Chrominance-Luminance Intermodulation | ±50% | ±0.5% | ±0.3% |
| Differential Gain | 0% to +50% | ±1% | ±0.3% |
| Differential Phase | 0° to +180° | ±0.6° | ±0.3° |
| Luminance Nonlinear Distortion | 0% to 50% | ±0.7% | ±0.35% |

**FREQUENCY RESPONSE MEASUREMENTS**

| Measurement | Range | Accuracy | |
|---|---|---|---|
| | | at 46 dB | at 60 dB |
| Multiburst Flag Amplitude | 15% to 125% of bar | ±0.5% | ±0.2% |
| Multiburst Amplitude (first five packets) | 0% to 200% of flag | ±3.0% (±3.5% on 4.8 MHz packet) | ±2.5% (±3.5% 4.8 MHz packet) |

**LINEAR WAVEFORM DISTORTION MEASUREMENTS**

| Measurement | Range | Accuracy | |
|---|---|---|---|
| | | at 46 dB | at 60 dB |
| Baseline Distortion | ±50% of bar | ±0.75% | ±0.5% |
| 2T Pulse/Bar Ratio Error | +25% to −90% | ±1.5% | ±1.25% |

**LOW FREQUENCY ERROR**

| Measurement | Range | Accuracy | |
|---|---|---|---|
| | | at 46 dB | at 60 dB |
| Low Frequency Error | 0% to 25% | ±1.0% | ±0.8% |

**NOISE MEASUREMENTS**

| Measurement | Range | Accuracy |
|---|---|---|
| Continuous Random Noise (weighted) | 34 dB to 73 dB<br>74 dB to 80 dB | ±2.0 dB<br>±2.5 dB |
| Signal-to-Unweighted Random Noise Ratio | 26 dB to 65 dB<br>66 dB to 72 dB | ±1.0 dB<br>±2.5 dB |

The Option 05 program is stored in PROMS on two circuit boards which plug into the 1980 base unit.

## 1980 ANSWER Option 06
### Dual Standard Applications Software

### Measurements on PAL and NTSC Video Signals

### All Features Present in the 1980 ANSWER Options 04 and 05

With the Option 06 Dual Standard Applications Software, ANSWER can make automatic or operator-initiated measurements on both PAL and NTSC video signals. The video standard in use on the incoming video signals is specified by the user, and thereafter Option 06 makes all measurements accordingly.

This program combines all features of Option 04 (NTSC Video Monitoring) and Option 05 (PAL video monitoring) into one program. The characteristics remain the same as in those programs.

The Option 06 program is stored in PROMS on two circuit boards which plug into the 1980 base unit.

## ORDERING INFORMATION

**For Base Unit Plus Software, Order:**

**1980 ANSWER with Option 01 — NTSC Applications Software ..... $26,000**

**1980 ANSWER with Option 04 — NTSC Monitoring Software ..... $26,800**

**1980 ANSWER with Option 05 — PAL Monitoring Software ..... $26,800**

**1980 ANSWER with Option 06 — PAL/NTSC Applications Software ..... 29,5000**

**Option 12** — Automatic Call Equipment ..... +$500

**For Software Only, Order:**

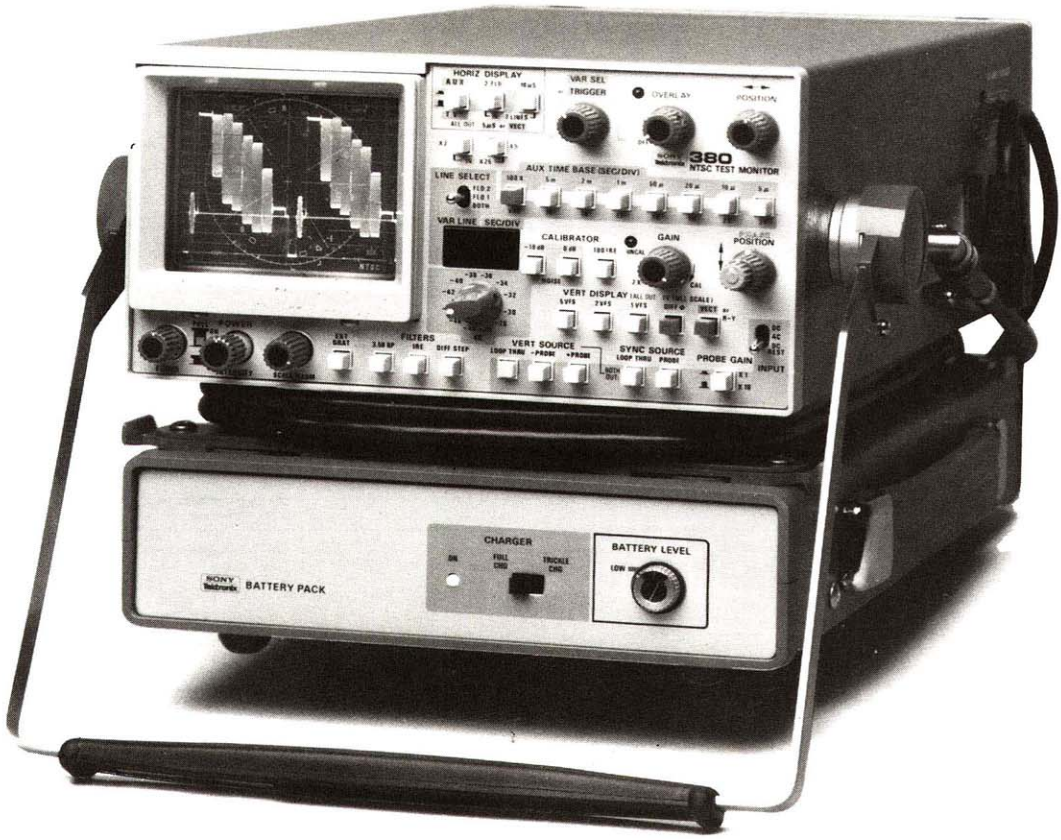
**1980 F04 ..... $5,800**

**1980 F05 ..... $5,800**

**1980 F06 ..... $8,500**

**OPTIONAL ACCESSORIES**

**Service Kit** — Order 067-1115-00




*380 Test Monitor with optional battery pack*

## 380

**Ac or Dc Operation**

**Bright CRT**

**Precise Frequency Response**

**Noise Measurement**

**Probe Input**

**Line Selection**

The 380 Test Monitor is a compact, lightweight instrument optimized for portability in many television environments, including maintenance, engineering and EFP. This unit has the combined capabilities of a precision waveform monitor, vectorscope, and general purpose oscilloscope.

The flexibility of the 380 makes it an ideal choice for a variety of applications. Video technicians, for example, find it invaluable when maintaining such video equipment as VTRs, cameras, and transmitters, particularly in remote locations. With an auxiliary oscilloscope trigger, sweep, and display, the 380 is also well-suited for maintaining other equipment, such as audio systems, servos, and control and switching systems.

Video engineers make good use of its extensive measurement capabilities, which include differential phase and gain, tangential noise, vertical interval line selection, short-time distortion, trace overlay, and a 0.5% calibrated amplitude comparator, to name only a few. The operator can choose to make video measurements from a 75-ohm or probe input.

Production personnel take advantage of the monitor's bright display and portability during remote productions, on EFP carts, in production vans, and in other remote applications. Pushbutton controls bring up standard horizontal (line) and vertical (field) waveform displays. A vectorscope display provides easy monitoring of color bars and chroma.

### Waveform Monitor

In the waveform monitor mode, the 380 has the flat frequency response (±2% to 5 MHz) required for measuring or monitoring a video signal. The monitors provide a full set of input filters, including chroma band pass, IRE or low pass, and differential step. The input signal can be ac or dc coupled, or dc restored, and switched between a loop-thru and probe input, with independent sync source selection. Calibrated vertical displays at 0.1 volts, 0.2 volts, 0.5 volts and 1.0 volts full scale, along with a variable gain control, provide a full range of amplitude control.

Digital and variable vertical interval line selection allows any individual line to be displayed and identified by line and field number. All displays can be expanded horizontally 2 times, 5 times or 25 times for increased clarity of fast signal components.

### Vectorscope

In the vectorscope mode, the vector display of either a full field or vertical interval signal can be selected. The display can be referenced to either the displayed signal or an external composite color video signal.

A decoded R-Y line sweep display is available.

### Oscilloscope

In the oscilloscope mode, a selectable time base from 50 milliseconds per division to 0.2 microseconds per division, along with negative or positive slope trigger for nonvideo signal observation are provided.

### Battery Pack

An optional battery pack (Option 11) attaches to the bottom of the 380 for complete portability, providing more than two hours of continuous operation. A convenient recharger is built into the pack. The battery pack is quickly replaceable for long term remote operation.

### CHARACTERISTICS

**Deflection Factor**

| | Loop Thru/Probe X10 | Probe X1 |
|---|---|---|
| 1 V | ≤1% | ≤2% |
| 0.5 V | ≤3% | ≤4% |
| 0.2 V | ≤3% | ≤4% |
| 0.1 V | ≤3% | ≤4% |

**Variable Volts Full Scale Range** — X0.2 (±4%) to ≈1.4.

**Maximum Input Signal** — Loop Thru: ±1.5 V dc + peak V ac, (dc coupled). ±2.0 V p-p at any APL (ac coupled). Probe X1: ±5 V dc + peak V ac <1 kHz (Signal Out not terminated). Probe X10: ±0.5 V dc + peak V ac, <1 kHz (Signal Out not terminated).

**Maximum dc Output into 75 Ω (Signal Out)** — ±0.5 V dc.

**Frequency Response** — FLAT (from 50 kHz reference). Loop Thru (Including Signal Out): +10°C to +30°C is 50 kHz to 5 MHz ±2%; 5 MHz to 10 MHz +2%, −5%. Loop Thru (Including Signal Out): +0°C to +50°C is 50 kHz to 5 MHz ±3%; 5 MHz to 10 MHz +3%, −5%. Probe: Typically <1 dB down to 15 MHz; <2 dB down to 18 MHz; <3 dB down to 20 MHz. IRE: Conforms to IEEE Standard 205, 1972. 3.58 MHz: ±1% of Flat at 3.58 MHz, bandpass ≈600 kHz. Diff STEP: Attenuation ≤2 dB from 0.4 MHz to 0.5 MHz; ≥20 dB at 14 kHz and 2 MHz; ≥40 dB at 3.58 MHz.

**Linear Waveform Distortion (2T)** — Pulse Aberrations: ≤1.0% of applied pulse amplitude within 1 μs of HAD points. 25 μs Bar Tilt: ≤1%. Field Squarewave Tilt: ≤1%. Pulse to Bar Ratio: 0.99 to 1.01:1 (at 1.0 V, 0.5 V or 0.2 V full scale). 0.98 to 1.02:1 (at 0.1 V full scale).

**Nonlinear Waveform Distortion** — Differential Gain Displayed: ≤0.5% at any APL. Signal Out: ≤1.0% of any APL. Differential Phase Displayed: ≤0.25° at any APL. Signal Out: ≤0.5° at any APL.

**Return Loss** — Loop Thru Input: ≥40 dB, dc to 5 MHz.

**Calibrator Accuracy** — 100 IRE: ≤0.5%. Noise: 0 dB = 700 mV ±5%. Step Accuracy: ≤1 dB. Instrument S/N: ≤−60 dB.

**Probe** — Input Resistance: 1 MΩ, ±2%. Input Capacitance: ≈24 pF. Maximum Safe Input Volt: 250 V dc + Peak V ac 1 kHz or less.

**1 V Cal Out** — Output Voltage: 1.000 V ±0.005 V. Waveform: Squarewave. Frequency: ≈1 kHz. Output Impedance: <1 Ω.

**Vertical Geometry** — ≤0.15 div error.

**Horizontal Geometry** — ≤0.15 div error.

**Sweep Timing Accuracy and Linearity (Over Center 10 Div)**
**TV Time Base** — At 5 μs timing 1%, linearity 2%; at 10 μs timing 2%, linearity 3%.

**Auxiliary Time Base** — Timing 4%, linearity 5%.

**Magnified Timing and Linearity** — X2, X5 and X25: Add 1%, error for center ten divisions of unmagnified sweep.

**Two Field Sweep Length** — 12.7 div; ±0.5 div.

**Field Selector** — Positive selection of Odd (2 and 4), Even (1 and 3).

**Line Selector** — Variable Range: From ≈ line 17 of the selected field to 25% into adjacent field; lines intensified by the strobe in two Field display.
Digital: Selects line 15 to line 21.

**Sync Input Requirements** — TV Sync: 200 mV p-p to 2 V composite video. Auxiliary Sync: ≤20 mV at 50 Hz; ≤10 mV at 50 kHz; ≤50 mV at 5 MHz.

**Chrominance Bandwidth** — Upper −3 dB Point: fsc +500 kHz ±100 kHz. Lower −3 dB Point: fsc −500 kHz ±100 kHz.

**Vector Phase Accuracy** — ≤2°

**Subcarrier Regenator** — Pull-in Range: Within 50 Hz of fsc. Pull-In Time: ≤1 s. Phase Shift with Subcarrier Frequency Change: <1° typically from fsc to fsc +10 Hz, or from fsc to fsc −10 Hz; <2° typically from fsc to fsc +20 Hz, or from fsc to fsc −20 Hz. Phase Shift with Burst Amplitude Change: ≤2° from nominal burst amplitude to ±6 dB. Phase Control Overall Range: ±30°. Vector Gain Accuracy: ≤2 IRE. Differential Phase Accuracy: ≤10% of measurement ±0.3°.

**Optional Battery Pack** — Power Output: 11 V dc to 12 V dc; 6 A hours (0°C to +40°C); 3 A maximum. Operating Time: >2 hours. Charge Time: 14 to 16 hours (0°C to +40°C).
Storage Temperature: (−40°C to +60°C).
Power Consumption: 30 W maximum.

**Mains Voltage Range** — 115 V ac: 90 V ac to 132 V ac. 230 V ac: 180 V ac to 250 V ac.

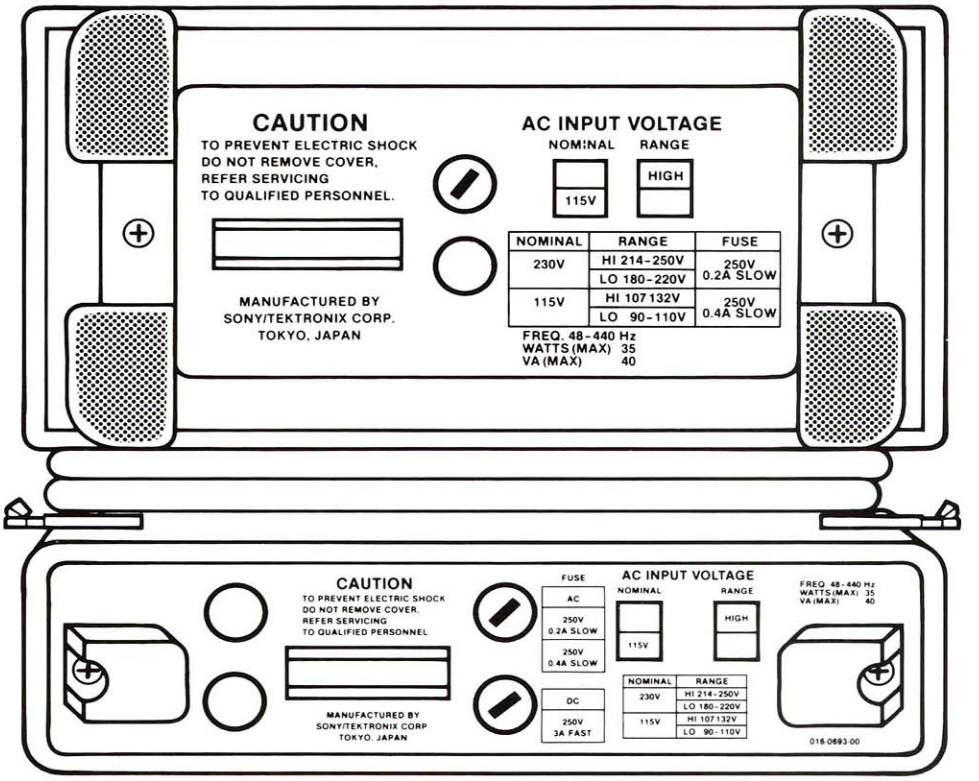
**Power Consumption** — 35 W.

**Mains Frequency** — 48 Hz to 440 Hz.

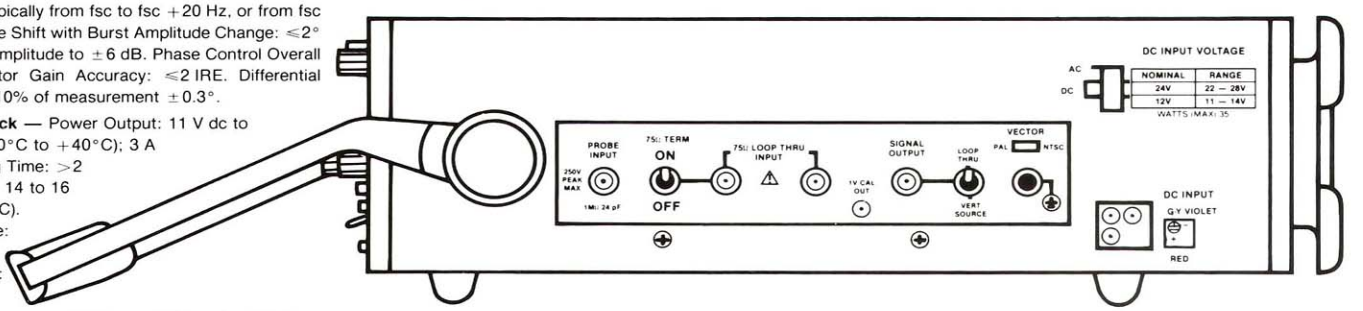
### ENVIRONMENTAL CHARACTERISTICS

**Temperature** — Operating: 0°C to +50°C. Nonoperating: −25°C to +75°C.

**Altitude** — Operating: To 4500 m (15,000 ft). Nonoperating: To 15 200 m (50,000 ft).




*380 optional battery pack back panels*




*380 side panel*

### PHYSICAL CHARACTERISTICS (380)

| Dimensions | mm | in |
|---|---|---|
| Width, w/handle | 237 | 9.5 |
| Height | 112 | 4.5 |
| Depth, handle not extended | 372 | 14.9 |
| Depth, handle extended | 482 | 19.3 |
| **Weight** | **kg** | **lb** |
| Net | 5.5 | 12.1 |

### BATTERY PACK

| Dimensions | mm | in |
|---|---|---|
| Width | 209 | 8.4 |
| Height | 68 | 2.7 |
| Depth | 353 | 14.1 |
| **Weight** | **kg** | **lb** |
| Net | 4.0 | 8.8 |

### INCLUDED ACCESSORIES

Probe package (010-6149-03); phase reference switch box (015-0438-00); external dc cable assembly (161-0094-01); carrying case (016-0663-02); 3 A, 250 V fast fuse (159-0015-02); 1.5 A, 250 V fast fuse (159-0156-00); 0.2 A, 250 V slow fuse (159-0180-00); 0.4 A, 250 V slow fuse (159-0179-00); cover carrying case (200-2260-00); carrying strap assembly (346-0131-02); viewing hood (016-0297-00); manual.

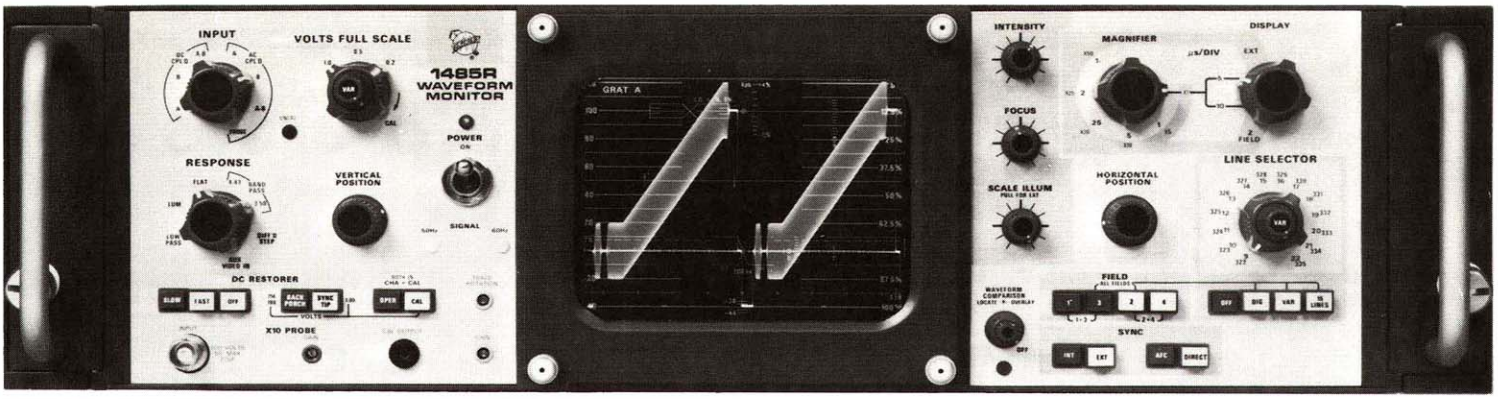
### ORDERING INFORMATION

**380** Test Monitor
(For NTSC Systems) ..... **$5,220**
**Option 11** — With Battery Pack Included ..... **+$495**
**Option 89** — Required for Export Orders ..... **NC**

### OPTIONAL ACCESSORIES

**Battery Pack** — Order 016-0693-00 ..... **$495**
**Camera** — Order C-30BP Option 01 ..... **$1,489**
**Camera Mounting Adaptor** — Order 016-0327-01 ..... **$170**

The SONY®/TEKTRONIX® 380 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 380 is available from Tektronix, Inc., its marketing subsidiaries and distributors.




*1485R Option 01 PAL/NTSC Dual Standard Waveform Monitor (Rackmount)*

## 1480 Series

**Bright CRT Especially Suitable for Vertical Interval Testing**

**Advanced Measurement Modes**

**Amplitude Measurement Accuracy Approaching 0.2%**

**Digital Selection of Line and Field**

**Probe Input Option**

**15-Line Display for VTR Applications**

The 1480 Series waveform monitors have excellent amplitude measuring accuracy and many unique operating modes that enable you to work more precisely and accurately. The monitoring needs of CCU, VTR, control room, transmission facilities, transmitter, and special systems are met by the use of 1480 Series waveform monitors. The 1485C and 1485R PAL/NTSC dual standard monitors (see photos) represent the essentials of all seven monitors in the 1480 Series. The differences between the monitors in the series are essentially confined to what lines in the vertical interval are selectable, what filters are selectable in the response mode, and in the field selection modes. Dual-Standard Monitors recognize the signal standard in use automatically and indicate that standard with front panel indicators.

### Vertical Interval Testing

Two features are needed in a waveform monitor used for vertical interval testing: A bright CRT and line selection.

The CRT in the 1480 Series is bright enough that one VITS (Vertical Interval Test Signal) selected out of four fields can be seen with ease even in a well-lighted area.

Two modes of line selection are provided in the 1480 Series waveform monitors: digital and variable.

Digital selection of field and line assures positive identification of displayed information. For example when you select line 18 of field 2 it is certain that what you will see is line 18, field 2. Digital techniques will not allow an incorrect selection.

Variable selection of other lines is provided for full field signal analysis. In all line selection modes a line intensifying strobe is provided with video for picture monitor displays. A second line strobe output is provided to strobe 520A Series vectorscopes, etc. Intensified two-field displays on the 1480 help you locate the line or lines selected.

### High Amplitude Measurement Accuracy

In recognition of the need for more accuracy the 1480's give you the capability to make amplitude measurements with accuracy approaching 0.2% using a precision display offset. A proven video measurement technique, offsetting displays with an amplitude standard is an easy-to-use method that achieves accuracy by eliminating parallax and transfer errors. Transfer errors are eliminated because you compare your signal to a precise one volt standard rather than to graticule calibration. Measurements made with comparison techniques also have a high order of consistency and repeatability. When your signal precisely matches the standard your signal amplitude will be determined to the value and accuracy of the offset. The tolerance of the internal calibration signal used as the standard is 0.2%.

### Trace Overlay

The 1480's can actually overlay a later segment of a display on the earlier segment. Superimposing waveforms over other waveforms allows exact comparison of levels. With overlay you can exactly compare the elements of complex vertical interval test signals.

### Probe Option

The 1480's make convenient high impedance probing available with a probe option. This option provides an input that accepts most Tektronix probes. As a part of this option a probe compensation waveform test point is provided (A ten-times amplifier keeps full screen sensitivities while using X10 attenuator probes.)

## CHARACTERISTICS

### VERTICAL DEFLECTION

**Inputs** — Input A and B are 75 Ω high impedance loop-through. Return loss is ⩾40 dB from dc to 5 MHz in a 75 Ω system. Aux Video Input is internally terminated in 75 Ω. Return loss is ⩾34 dB from dc to 5 MHz.

**Scale Factor** — A and B input calibrated 1.0 V ±7 mV, 0.5 V ±15 mV, 0.2 V ±7 mV. (0.05 V ±2.5 mV Option 06) volts full scale. Variable: Range for each scale factor at least +40% to −50%. Aux Video Input 1.5 dB gain.

**Maximum Input Voltage** — 2 V p-p (ac coupled), ±1.5 V dc + peak ac (dc coupled).

**Frequency Response**

FLAT: 50 kHz to 5 MHz ±1% (1.0 V F.S., VAR in detent). 5 MHz to 8 MHz +2, −3%, 8 MHz to 10 MHz +2, −6%. Typically within +2, −15% to 18 MHz and typically −3 dB at 20 MHz.

Low Pass: Attenuation ⩾14 dB, 500 kHz and above. 3.58 MHz Bandpass: Amplitude within ±1% of amplitude in Flat response position. Bandpass ≈600 kHz. 4.43 MHz Bandpass: Amplitude within ±1% of amplitude in flat response position. Bandpass ≈800 kHz. IRE: Conforms to IEEE Standard 205, 1972.

**Linear Waveform Distortion**

Pulse/Bar Ratio: ±1%. For NTSC or PAL 2T Pulse or NTSC T Pulse.

Short Time: Preshoot, overshoot, ringing ⩽1% of NTSC or PAL T Pulse and Bar.

Line Time: Tilt or rounding ⩽1.0%. Field Time: (Ac coupled) ⩽1%.

**Nonlinear Distortion** — Differential Gain: ⩽0.5%.

**Dc Restorer** — Keyed type, may be turned off. Clamping point: Back Porch/Sync Tip. Time Constant: FAST reduces mains hum ⩾26 dB, SLOW reduces mains hum <0.9 dB.

**Calibrator** — Amplitude selected by dc Restorer switch. Sync Tip: 1 V ±0.2%. Back Porch: 714 mV or 700 mV ±0.5%.

### HORIZONTAL DEFLECTION

**Time Base** — 5 μs and 10 μs timing accuracy ±2% (center 10 divisions); 5 μs and 10 μs linearity ±1% (center 10 division).

**External Sync Input** — Two loop-through high impedance, with ⩾46 dB return loss in a 75 Ω system. Inputs are slaved to A and B input or to A external sync input only.

**External Sync Input Requirements** — 400 mV to 2 V composite video or 200 mV to 8 V composite sync.

**Field Selector** — Positive selection of Field 1 or Field 2 in the NTSC system. Positive selection of 1, 2, 3, 4, or 1 & 3, 2 & 4 in the PAL systems.

**Line Selector** — Dig: Selects lines 9 to 22 NTSC, line 9/322 to line 22/335 PAL, line 9/272 to line 22/285 PAL-M. Var: Approx line 20 of the selected field to line 4 of the next related field. 15 lines: Identical to Var, except 15 successive lines are displayed.

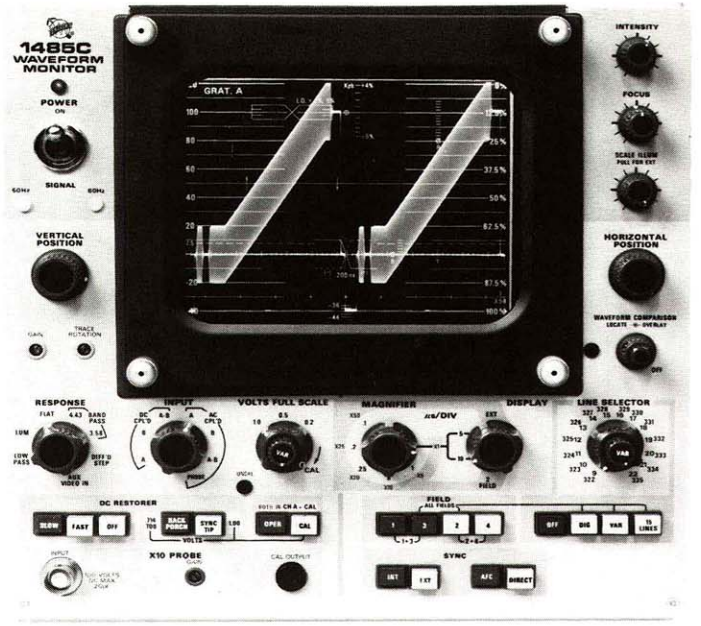
**Sync** — AFC horizontal frequency range is 15.75 kHz ±200 Hz. Maximum Jitter with Respect to Input Sync: 10 ns with 4 V RMS hum (30 ns with the addition of −36 dB white noise). Direct horizontal frequency up to ⩽20 kHz. Maximum Jitter with Respect to Input Sync: 12 ns with 4 V RMS hum (90 ns with the addition of −36 dB white noise).

### OUTPUTS

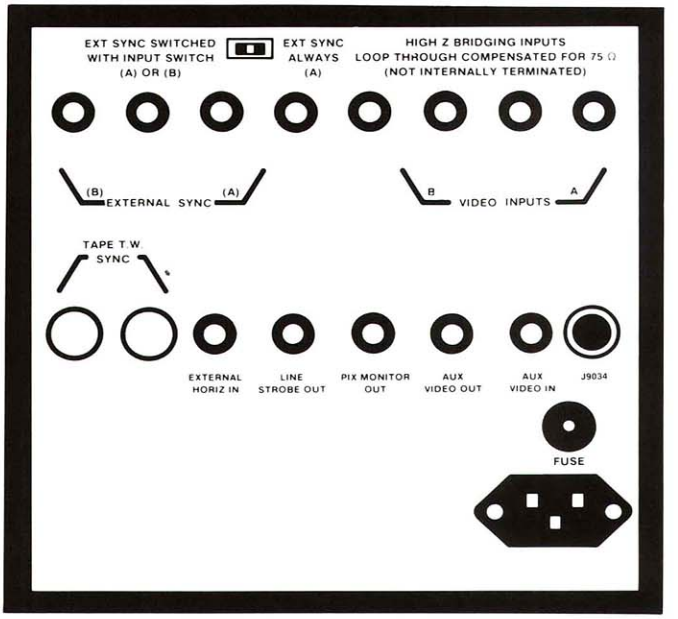
**Line Strobe** — TTL amplitude pulse. Pulse coincident with line or lines selected by VAR, 15 LINE or DIG modes of DISPLAY switch.

**Picture Monitor** — Output of incoming video with Line Strobe added. Output impedance is 75 Ω. Output gain adjusted to unity with respect to A and B video input.

**Aux Video** — Output of incoming video. 75 Ω output impedance. Gain adjustable to unity with respect to A and B video input.




*1485C PAL/NTSC Waveform Monitor (Cabinet)*




*1485C Rear Panel*

### OTHER CHARACTERISTICS

**RGB/YRGB Staircase Input** — ≈12 V for 12.7 divisions deflection. RGB sweep length internally selected for 1/3 normal sweep. YRGB sweep length internally selected for 1/4 normal sweep length.

**Mains Voltage** — Ranges 100 V ac, 110 V ac, 120 V ac, 200 V ac, 220 V ac, 240 V ac ±10%. Frequency 48 Hz to 62 Hz, maximum power consumption 75 W. At factory, 1480, 1482 preset for 110 V ac. 1481, 1485 preset for 220 V ac.

### CHARACTERISTICS (OPTION 01)

**10X Probe Channel** — Scale Factor: 1 V, 0.5 V, 0.2 V full screen with 10X attenuator probe. Gain Range: ±10%. Tilt: ≤5% on 50 Hz. Squarewave High Frequency Response: ±3%, 25 Hz to 5 MHz. Referenced to 50 kHz. Input Resistance 1 MΩ, ±2%, not including probe. Input RC Product: 20 μs, ±1%, not including probe. BNC connector accepts most Tektronix probes.

**10X Probe Calibrator** — Output voltage 1,000 V ±0.005 V or 0.995 V to 1.005 V.

### SLOW SWEEP CHARACTERISTICS (OPTION 07)

**Duration** — 4 to 12 s, variable with front panel control.

**Linearity** — ±5% of full-screen over the length of the sweep.

**Indicator** — Front panel indicator on when slow sweep is operating but sweep is not running.

**Triggering Signal** — APL change ≤10% to 90% (Bump or Bounce), front panel selectable for either + or − level change.

**Sensitivity** — 400 mV to 2 V p-p composite video with APL change.

**Rate** — ≥0.2 Hz, free-runs at rates <0.2 Hz or with no triggering signal.

**Input** — Internal or External.

**50Hz/60 Hz Squarewave Triggering** — Sensitivity: 400 mV p-p minimum to 3 V p-p maximum. Input Impedance: ≈10 kΩ ac coupled (Rear Panel loop-through connectors not return loss compensated.)

### PHYSICAL CHARACTERISTICS

| | 1480C | | 1480R | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 216 | 8.5 | 482 | 19.0 |
| Height | 210 | 8.3 | 133 | 5.3 |
| Depth | 430 | 16.9 | 457 | 18.0 |
| **Weights ≈** | **kg** | **lb** | **kg** | **lb** |
| Net | 9.8 | 21.5 | 11.2 | 24.6 |
| Shipping | 24.1 | 53.1 | 24.1 | 53.1 |

### INCLUDED ACCESSORIES

Two BNC right angle adaptors (103-0031-00); One pair rack-mount ext DWR Slides (351-0195-01); various external graticules (see matrix below); manual.

| External Graticules w/Tek P/N | 1480R/C | 1481R/C | 1482R | 1485R/C |
|---|---|---|---|---|
| Blank 331-0393-00 | x | x | x | x |
| NTSC Composite 331-0393-01 | | | | x |
| CCIR 331-0393-02 | | | | |
| CCIR K Visual 331-0393-05 | | x | | x |
| CCIR K Photo 331-0393-07 | | x | | x |
| GRAT A Visual 331-0393-08 | | | | x |
| GRAT B Visual 331-0393-18 | x | | | x |
| GRAT A Photo 331-0393-10 | | | | x |
| GRAT B Photo 331-0393-17 | x | | | x |

### ORDERING INFORMATION

**1480C NTSC** Waveform Monitor ..... **$6,300**
**1480R NTSC** Waveform Monitor ..... **$6,300**
**1481C PAL** Waveform Monitor*1 ..... **$5,865**
**1481R PAL** Waveform Monitor*1 ..... **$5,865**
**1482R PAL-M** Waveform Monitor ..... **$6,790**
**1485C PAL/NTSC** Dual Standard Waveform Monitor*1 ..... **$6,300**
**1485R PAL/NTSC** Dual Standard Waveform Monitor*1 ..... **$6,300**

**Option 01** — 1 MΩ, 20 pF Probe Input (not available with Option 06, probe not included) ..... **+$300**
Suggested Probe: P6108 10X Probe 2 m (010-6108-03); or 3 m (010-6108-05) ..... **$100**

**Option 06** — 124 Ω WECO Style Inputs (1480R only) ..... **+$2,075**

**Option 07** — Slow Sweep*2 (Option 07 performance included with Option 06. Do not order with Option 06) ..... **+$510**

**Option 08** — SECAM Field Identification (1481C, 1481R, 1485C and 1485R only) ..... **+$315**

**1 1481C/R, 1485C/R meets European Broadcast Union Tech. 3221-E, Guiding Principles for design of Television Waveform Monitors.*

**2 Option 07 satisfies EBA Tech 3321-E § 3.2.2.*

### OPTIONAL ACCESSORIES

**1480R Cradle Assembly** — For mounting the 1480R in a WECO backless rack. Order 426-0309-00 ..... **$40**

**Field Case** — (For cabinet versions only). Order 016-0084-00 ..... **$120**

**Trace Recording Cameras** — Both the Tektronix C-53P and the C-59AP can be used. The C-53P gives the largest image possible on Polaroid pack film. The C-53P requires a battery pack (016-0270-02) and camera mounting adaptor (016-0342-00). The C-59AP is less expensive but produces a smaller image on the film. The C-59AP requires a camera adaptor (016-0224-01). See camera section of this catalog.

*528A Waveform Monitor mounted side by side with a 1420 Vectorscope.*

## 528A/1420 Series

**Parallax-Free Internal Graticule**

**Half Rack Width**

**Proven Performance**

**Available in NTSC, PAL, PAL-M Models**

The 528A Waveform Monitor and 1420 Series vectorscopes and X-Y monitors provide complete monitoring of your video signal. One 528A and one 1420 Series monitor mounted side by side in the optional rack adaptor provide a continuous display of both the luminance and chrominance information of your video signal, whether your signal is in the NTSC, PAL, or PAL-M format.

These monitors are ideally suited for use in camera, VTR, video production and post production monitoring applications. They all have simple-to-understand and easy-to-use controls.

### CHARACTERISTICS (528A)

**Inputs** — Two Rear Panel BNC Connectors (A and B): Provide two 75 Ω loop through connectors (normally ac coupled but may be easily modified for dc coupling).

**Video Output** — The displayed signal is provided at the Video Out rear panel connector.

**Dc Restoration** — Slow acting back porch dc restoration.

**Calibrator** — An internal calibration signal provides a convenient reference to verify the deflection factor. Calibrator amplitude is 1.0 V p-p ±1%.

#### TIME BASE

Provides four time base operating modes; baseline visible in each mode with no external video or sync inputs.

#### EXTERNAL SYNC

**Input Signal Levels** — 1.5 V to 4.5 V p-p (composite sync will synchronize sweeps).

#### YRGB AND RGB

The 528A can be used with color camera processing amplifiers that provide the necessary signal switching and staircase signals.

### CHARACTERISTICS (1420, 1421, 1422)

**Chrominance Bandwidth** — Upper −3 dB Point: Fsc +550 kHz ±100 kHz; Lower −3 dB Point: Fsc −550 kHz ±100 kHz.

**Vector Phase Accuracy** — Within 1°.

**Phase Control Range** — 360° continuous rotation with goniometer.

**Input Amplitude Range** — 1 V ±6 dB.

**Front Panel Gain Control Range** — Unity to +15.12 dB; Unity to −6 dB.

**Input Return Loss** — At least 46 dB to 5 MHz.

**Differential Phase** — 1° or less.

**Differential Gain** — 1% or less.

#### AC POWER

**Line Voltage Ranges** — 99 V ac to 132 V ac and 198 V ac to 250 V ac (528A). 90 V ac to 132 V ac and 180 V ac to 250 V ac (1420 Series).

**Typical Power Consumption** — 48 W (528A). 45 W (1420, 1421, 1422).

**Mains Frequency** — 48 Hz to 66 Hz.

#### SAFETY

528A Waveform Monitors are CSA556B certified. With cover or carrying case installed they meet the requirements for listing under UL 1244. 528A's without a cover are UL recognized components.

#### PHYSICAL CHARACTERISTICS (528A/1420 SERIES)

| Dimensions | mm | in |
|---|---|---|
| Width | 216 | 8.5 |
| Height | 133 | 5.3 |
| Depth | 470 | 18.5 |
| **Weights (528A)** | **kg** | **lb** |
| Net (with accessories) | 6.8 | 15.0 |
| Shipping | 10.4 | 23.0 |
| **Weights (1420 Series)** | **kg** | **lb** |
| Net (with cabinet) | 7.0 | 15.5 |
| Net (without cabinet) | 5.9 | 13.0 |
| Shipping | 9.1 | 20.0 |

#### INCLUDED ACCESSORIES

9-pin plug connector for 528A (136-0099-01); manual; 75 Ω termination for 1420, 1421, 1422 (011-0102-00).

### ORDERING INFORMATION

**These instruments are configured for rackmounting and are shipped without cases or covers. To configure for bench or portable use, order appropriate optional accessories.**

**528A Option 01** Waveform Monitor (for use with 525 line systems) ..... **$2,300**

**Option 03** — (Modified for use with 625 line systems and for 230 V ac power, unless otherwise specified.) ..... **NC**

**1420 Option 01** Vectorscope (for NTSC, factory wired for 115 V ac power) ..... **$2,820**

**1421 Option 01** Vectorscope (for PAL, factory wired for 230 V ac power) ..... **$2,920**

**1422 Option 01** Vectorscope (for PAL-M, factory wired for 115 V ac power) ..... **$3,185**

#### OPTIONAL ACCESSORIES

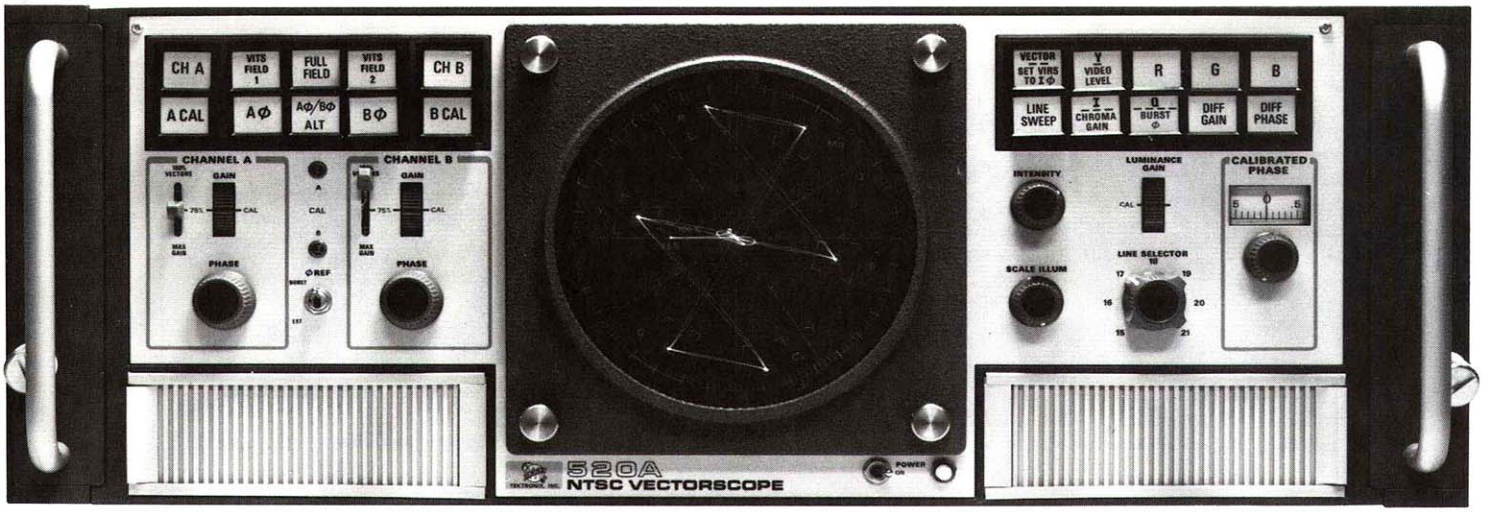
**Cover** — Unfinished aluminum, no handle or feet. Order 437-0100-01 ..... **$60**

**Carrying Case** — Painted, with handle and feet. Order 390-0018-01 ..... **$85**

**Camera** — Use standard C-59AP, C-4 Option 02, or standard C-5C. (See camera section of this catalog).

**Side-by-Side Rack Adaptor** — (For two half-rack instruments). Order 016-0115-02 ..... **$225**

**Blank Panel** — For rack adaptor. Order 016-0116-00 .... **$42**




*R520A NTSC Vectorscope*

## R520A/R521A/R522A

**Luminance Amplitude**

**Chrominance Amplitude and Phase**

**Precision Differential Phase**

**Precision Differential Gain**

The Tektronix R520A Series vectorscopes include three basic instruments. These are the R520A for NTSC, the R521A for PAL, and the R522A for PAL-M.

### DISPLAYS

The vector display shows the relative phase and amplitude of the chrominance signal on polar coordinates. To help identify these coordinates, the graticule has points corresponding to the proper phase and amplitude of the primary and complementary colors: R (Red), B (Blue), G (Green), $C_Y$ (Cyan), $Y_L$ (Yellow), and $M_G$ (Magenta).

Any errors in the color encoding, video-tape recording, or transmission processes that change these phase and/or amplitude relationships cause color errors in the television picture. Polar coordinate displays, such as those obtained on the R520A, R521A, and R522A CRT, have proven to be the best method for displaying these errors.

The polar display permits measurement of hue in terms of relative phase of the chrominance signal with respect to the color burst. Amplitude is expressed in terms of the displacement from center (radial length) toward the color point which corresponds to 75% (or 100%) amplitude of the particular color being measured.

The outer boxes around the color points correspond to phase and amplitude error limits (±10°, ±20%). For the R520A (NTSC) the inner boxes indicate ±2.5° and 2.5 IRE units, and correspond to phase and amplitude error limits per EIA specification RS-189, amended for 7.5% setup. For the R521A (PAL) and R522A (PAL-M), the inner boxes indicate ±3° phase angle and ±5% amplitude.

An internally generated test circle, used with the vector graticule, verifies quadrature accuracy, horizontal to vertical gain balance, and gain calibration for chrominance signal amplitude measurements. Two methods of measuring phase shifts are provided. You can accurately read large phase shifts from the parallax-free vector graticule. A precision calibrated phase shifter with a range of 30°, spread over 30 inches of dial length, is provided for measuring small phase shifts.

### Dual Vector Display

In dual-channel operation, successive samples of channels A and B are displayed on a time-shared basis. The switching rate is locked to horizontal sync, and switching transients are blanked. You can conveniently compare input/output signals from video equipment on Channel A or B for phase and/or amplitude distortion.

The subcarrier processing channel contains two uncalibrated 0° to 360° phase-shifters and one 30° calibrated phase shifter. While viewing Channel A or B, you can switch either of the uncalibrated phase-shifters, AØ or BØ into the subcarrier processing channel. Each phase shifter locks to its respective channel when A and B channels are time-shared, permitting independent phase control of the Channel A and B displays. Unequal signal paths causing phase shifts are easily cancelled, leaving only phase and amplitude distortion caused by equipment deficiencies.

Video cable lengths may be accurately matched for time delay at color subcarrier frequency to less than 0.5° phase difference.

You can make accurate amplitude measurements of chrominance and luminance from the CRT display. Use the internal one volt luminance amplitude calibration test signal to check the gain accuracy of Channel A and B amplifiers and the luminance channel.

### Time Base Displays

The linear time base operates at the line rate. Color signals may be demodulated along any desired axis, I, Q, and R-Y (for NTSC), and U, and V (for PAL and PAL-M), and displayed at the line rate on a linear time base.

### Luminance-Color Separation

A luminance channel permits the separation and display of the luminance (Y) component from the composite color signal. You can also combine the Y component with the output of the chrominance demodulators for R, G, and B displays at a line rate. Amplitude measurements of color signal components can be made with an accuracy of 3%.

### Vertical Interval Test Signal Observation

You can display VITS (Vertical Interval Test Signals) from front-panel selected lines of either field 1 or 2 on the R520A Vectorscope. For the R521A (PAL) and the R522A (PAL-M), you can display ITS from either fields 1 and 3 or fields 2 and 4.

### Differential Gain and Differential Phase Measurements

The two main chrominance signal distortions — differential gain and differential phase — can be measured on the R520A (NTSC), R521A (PAL), and R522A (PAL-M) Vectorscopes. Differential gain (Figure 1) is a change in color subcarrier amplitude as a function of luminance level. In the reproduced color picture, saturation will be distorted in the areas between the light and dark portions of the scene. The R520A, R521A, and R522A permit differential gain measurements with accuracy to better than 1%.

Differential phase (Figure 2) is a phase modulation of the chrominance signal caused by changes in the luminance signal level. The hue will vary with scene brightness in the reproduced color picture. Differential gain and differential phase occur separately or together. You can read differential phase errors from the precision calibrated phase shift control or directly from the differential phase markings on the graticule.

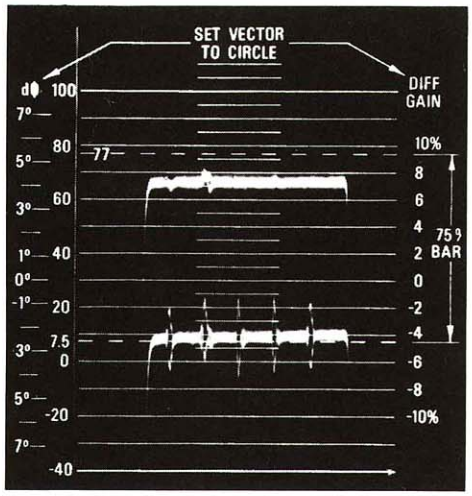
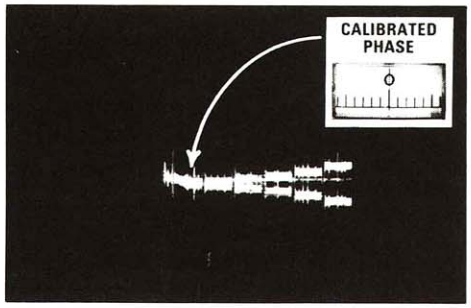



*Figure 1. Differential Gain display from the R520A. Luminance is on in lower trace. On upper trace, luminance is off. Minor divisions of graticule indicate 1% differential gain. Double exposure.*



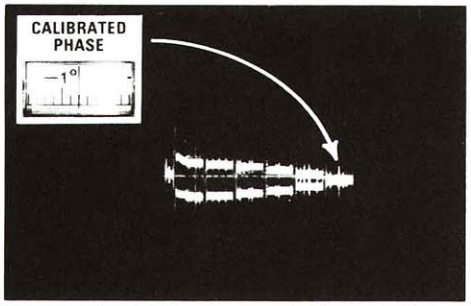




*Figure 2. Differential Phase presentation from the R520A using a modulated staircase signal. Trace overlay technique provides excellent resolution for measuring small phase changes. The differential phase error from the reference point in top photo (first step of staircase signal overlayed) to point of measure in bottom photo (sixth step overlayed) is 1.2°.*

## CHARACTERISTICS

**Graticule** — Two separate graticules provide reference for vector and line sweep displays. The parallax-free vector graticule, or the luminance graticule, is automatically selected and edge-lighted concurrent with operating mode selection.

**Z-Axis Input** — The Z-Axis Input connector accepts external trace-brightening pulses for intensifying a portion of the display during the time of interest.

**Video Inputs** — Dual BNC input connectors for each channel permit 75 Ω loop-through operation with a return loss >46 dB to 5 MHz (exceeds CCIR recommendation 567, Part D and D.2). Amplitude range is 0.7 V to 1.4 V Video (sync tip to peak white).

### AC POWER

**Mains Voltage Range** — 90 V ac to 136 V ac or 180 V ac to 272 V ac.

**Mains Frequency** — 47 Hz to 63 Hz.

**As displayed on 520A**

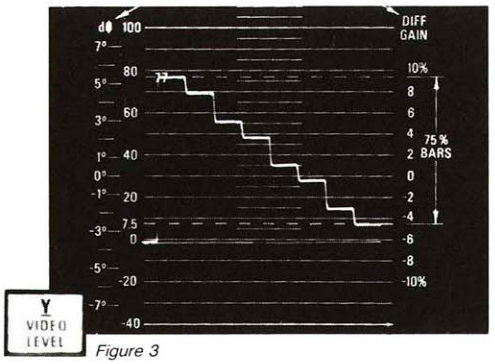



*Figure 3*

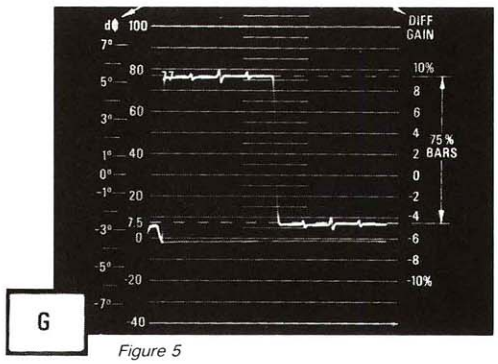



*Figure 5*

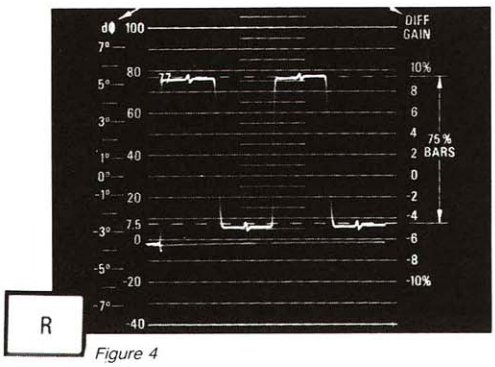



*Figure 4*

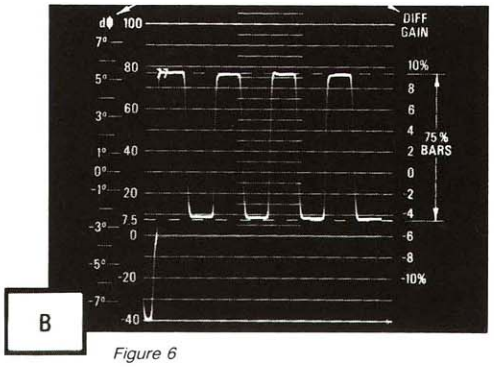



*Figure 6*

*75% amplitude Color Bar Signal displayed on the line sweep graticule. Pushbuttons select line-sweep displays of luminance (Figure 3), decoded Red (Figure 4), decoded Green (Figure 5), and decoded Blue (Figure 6).*

**Power Consumption** — 95 W maximum at 115 V ac/60 Hz. (Rear panel selector provides rapid accommodation to six line-voltage ranges. Factory set at 115 V ac for the R520A and R522A and 230 V ac for the R521A.)

### ENVIRONMENTAL CHARACTERISTICS

**Operating Temperature Range** — 0°C to +50°C ambient.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 483 | 19.0 |
| Height | 178 | 7.0 |
| Depth | 483 | 19.8 |
| **Weights** | **kg** | **lb** |
| Net | 15.0 | 33.0 |
| Shipping ≈ | 27.7 | 61.0 |

### INCLUDED ACCESSORIES

Smoke-gray filter, installed (378-0581-00); rackmounting hardware, and slide-out assembly (351-0195-01); manual.

## ORDERING INFORMATION

**R520A** NTSC Vectorscope ..... **$8,525**
**R521A** PAL Vectorscope ..... **$8,050**
**R522A** PAL-M Vectorscope ..... **$9,540**

### OPTIONAL ACCESSORIES

**75 Ω Voltage Step-Up Termination** — When used with a Tektronix vectorscope, the 75 Ω Voltage Step-up Termination provides an X5 increase in chrominance amplitude and lets you make more accurate Differential Gain and Differential Phase measurements. Input impedance to the termination is a constant 75 Ω. Use of the termination requires a source of external sync to the vectorscope.

**Voltage Step-up Termination** — For use with R520A (NSTC), R522A (PAL-M) Vectorscopes. Order 011-0100-01 ..... **$85**

**Voltage Step-up Termination** — For use with the R521A Vectorscope. Order 011-0109-00 ..... **$120**

**Single Sideband Chroma Amplitude Corrector** — Designed for use with a Tektronix vectorscope in transmitter applications where a vestigial sideband signal is being demodulated with a detecting diode. The corrector provides an X2 increase in chrominance amplitude and passes luminance components with little or no attenuation. Input impedance is 75 Ω.

**Chroma Amplitude Corrector** — For use with R520A (NTSC), R522A (PAL-M) Vectorscopes. Order 011-0107-01 ..... **$110**

**Chroma Amplitude Corrector** — For use with R521A Vectorscope. Order 011-0108-01 ..... **$120**

**Recommended Camera** — For Display Photographs: C-59AP with mounting adaptor 016-0295-01. See camera section of this catalog for information.

**R520A Cradle Assembly** — For mounting the R520A in a WECO backless rack. Order 426-0667-00 ..... **$40**

**Rackmount to Cabinet Conversion Kit** — Order 040-1153-00 ..... **$50**

*650HR High Resolution Color Monitor*

## 650HR

**High Resolution Display Plus Capability for Critical Signal Analysis**

**0.25 mm Triad Pitch High Resolution Trinitron CRT**

**Variable Aperture Correction**

**Precise Color Tracking Over Full Signal Range**

**Two Video Inputs with Differential (A-B) Capability**

**Video Inputs Isolated from Ground for Hum Rejection**

**Capability for Front Panel Switching of External Sync Inputs**

**NTSC, PAL and Multistandard Decoders Available**

**Precise Decoders with Outputs to Provide Vector Display on External X-Y Monitor**

**Unique Monochrome (White) Display of Decoded Blue Signal for Critical Analysis of Color Noise**

The Tektronix 650HR Series color picture monitors are designed for exacting applications where picture quality and signal quality analysis are particularly important. The 650HR uses a Trinitron CRT with resolution capabilities which exceed the performance of encoded television signals. The decoders have sufficient chroma channel bandwidth to pass all of the information in standard signals.

The unique blue only mode feeds the decoded blue video signal to the red, green, and blue channels simultaneously. This produces a monochrome display with a high subjective sensitivity to chroma noise, allowing better analysis of video quality.

The chrominance channel may be manually switched to either the monochrome or color modes, or activated automatically by the presence of burst.

Circuits in the Tektronix 650HR Series are designed for color stability and consistency. Outputs are provided from the precision decoders and may be used to drive an X-Y monitor for a vector display. The regulated EHT supply is not affected by extreme changes in APL even when calibrated brightness, at peak white, is set at 30 fL. Raster size is held within 1%, while excellent clamping maintains a stable black level with a 0% to 100% range of APL.

In 650HR Series color monitors, you can shift the picture either horizontally or vertically, or both (pulse cross). This lets you monitor sync, burst, blanking, vertical interval test, and reference signals. When the monitor is operating in any of these display modes, brightness is automatically advanced to permit observation of the sync pulses and burst. Expansion of the vertical scan is provided in the pulse cross and vertical delay modes; so you can view individual lines in the vertical blanking interval.

The 650HR Series monitors can be used in rack installations or separately in their own cabinets. They are compact, requiring only 276 mm (10.5 in) vertically. Versions are available for NTSC and PAL systems. Dual standard and RGB input versions are also available.

### CHARACTERISTICS

**Input Signal Level** — 0.5 V p-p minimum composite video 2 V p-p maximum. (Exceeds CCIR recommendations 567, Part D and D.2.)

**Impedance** — Unterminated: High Z bridging inputs loop-through compensated for 75 Ω (not internally terminated). Return Loss: ≥46 dB to 5 MHz, power on or off, input in use or not.

**Maximum Safe Input** — Exceeds CCIR Recommendation 451-2 (±5 V peak).

**Hum Rejection** — Hum is ≥50 dB down when 4 V maximum RMS common-mode mains hum signal is applied to the monitor in floating ground mode.

**NTSC Luminance Channel** — Bandwidth (notch filter removed) ≈6 MHz. Subcarrier notch filter automatically removed when burst is not present and Mode switch is in Auto position. Subcarrier notch filter removed when Mode switch is in Monochrome position. Dc Restoration back porch type; not affected by burst. Mains hum reduction due to dc restorer is <6 dB. Amplitude Linearity: Within 2%.

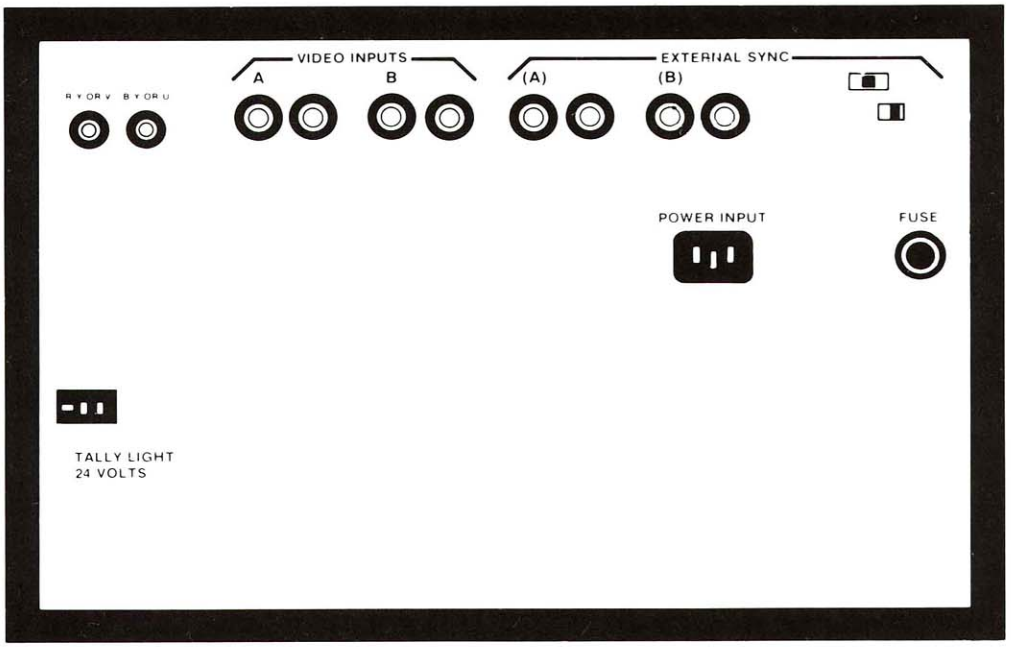
**NTSC Chrominance Channel** — Demodulation Axis: R-Y, B-Y. Bandpass: 1.3 MHz equiband. Gain Range: Preset at 0 dB; adjustable from −6 dB to +10 dB.

**PAL Luminance Channel** — Bandwidth (notch filter removed) ≈6 MHz. Subcarrier notch filter can be removed by changing internal jumper. Subcarrier notch filter normally left in circuit.

**PAL Chrominance Channel** — Demodulation Axis: U, V. Bandpass: ≈1.2 MHz. Gain Range: Preset at 0 dB; adjustable from −6 dB to +10 dB.

**Residual Subcarrier Detection (On Applied Signal)** — Color of displayed picture will shift due to any residual subcarrier. This feature can be inhibited by a jumper on the decoder board.

**Chrominance/Luminance** — Time Error: <30 ns. Gain Error: <3%.




*Rear Panel*

**Delay** — Red to green to blue <50 ns.

**Subcarrier Regeneration** — Phase Error: Within 1° with input burst variation of ±10 Hz from subcarrier nominal burst frequency. With Temperature Variation: Within 5° with ambient temperature variation from 0°C to +50°C; with 1° for any +10°C increment within the range 0°C to +50°C. With Input Signal Variation: Within 1° with input signal variations of ±3 dB from 1.0 V, within 3° with variation of burst/sync ratio of −6 dB to +10 dB. Breezeway Stability: ≤0.2° for burst timing errors including burst width variance (8 to 11 cycles), and breezeway variance ±0.28 μs. Phase Error Due to Noise: Within 1° with RMS white noise at −24 dB (0 dB = 700 mV RMS).

### PICTURE

**Height** — 184 mm (7.2 in).

**Width** — 244 mm (9.6 in).

**Underscan** — ≈20% reduction in both height and width.

**Aspect Ratio** — 4:3.

**Deflection Linearity** — Vertical and Horizontal: 1% of picture height within a central area bounded by a circle whose diameter equals picture height, ±2% of picture height outside of central area.

**Convergence Error** — <1 mm within the central area. Outside of the central area, color separation (misconvergence) is <2 mm.

**Unblanking** — All active picture elements are displayed. (Horizontal retrace is accomplished within 10 μs.)

**Color Temperature** — 6500°k. Easily adjustable to other standards.

**Calibrated Contrast** — 30 fL at peak white of standard 1 V signal.

**Calibrated Brightness** — Displayed black may be preset to a level appropriate for ambient conditions.

**EHT (Extremely High Tension)** — 19 kV nominal, regulated. Load variations cause <1% picture size variation. Monitor complies, as of date of manufacture, with applicable DHHS standards under Radiation Control for Health and Safety Act of 1968.

**Kinescope Protection** — Failure of horizontal or vertical scanning shuts off the EHT. Failure of HV Regulator circuit does not cause EHT to soar excessively. EHT supply is current limited.

**Heater Voltage** — Regulated dc.

### SYNC and TIMING

**Signal Range** — Composite sync 0.5 V p-p to 8 V p-p or composite video 0.5 V p-p to 2 V p-p.

**Impedance** — Unterminated: High Z bridging inputs loop-through compensated for 75 Ω (not internally terminated). Terminated: 75 Ω. Return Loss: ≥46 dB to 5 MHz with respect to 75 Ω.

**Synchronization** — Stable subcarrier regeneration, limited by line sync performance. Line sync white noise immunity is 20 dB. Field sync white noise immunity is 20 dB. Field sync stable with tilt equal to 100% of sync amplitude in vertical blanking. Stable with 20 IRE mains hum.

**AFC (Two Loop AFC Type)** — Phase Corrector: Corrects for phase errors due to side pincushion correction and other effects within the monitor. Slow AFC: Displays timing errors of incoming sync, particularly, 60 Hz or 240 Hz timing errors. Bandwidth is ≈25 Hz. Fast AFC: Largely corrects for incoming sync errors, ≈2 kHz bandwidth.

**Scan Delay** — Horizontal Delay: ≈¼ line; displays burst. Vertical Delay: Displays the vertical blanking interval of the input signal expanded ≈2.5 times unless underscan is activated. If the underscan button is depressed, vertical expand is inhibited.

### AC POWER

**Mains Voltage Range** — 115 V: Within 10% (104 V ac to 126 V ac). 230 V: Within 10% (207 V ac to 250 V ac maximum). 650HR, 650HR-1 are factory set for 115 V. 651HR, 651HR-1, 655HR-1 and 652HR-1 are factory set for 230 V.

**Crest Factor** — ≥1.3.

**Mains Current** — 1.5 A RMS maximum at 115 V, 60 Hz. 0.75 A maximum at 230 V, 50 Hz. Current is substantially higher during degaussing.

**Degaussing Surge Current** — 5 A RMS.

**Power Consumption** — 150 W maximum, 110 W typical.

**Mains Frequency** — 48 Hz to 66 Hz.

### ENVIRONMENTAL CHARACTERISTICS

**Temperature Range** — Operating: 0°C to +50°C. Nonoperating: −40°C to +65°C.

**Altitude Range** — Operating: to 4.5 km (15,000 ft). Nonoperating: to 15 km (50,000 ft).

**Shock** — To 30 g's, ½ sine, 11 ms duration.

### PHYSICAL CHARACTERISTICS

| Dimensions | Cabinet | | Rackmount | |
|---|---|---|---|---|
| | mm | in | mm | in |
| Width | 426 | 16.8 | 483 | 19.0 |
| Height | 279 | 11.0 | 266 | 10.5 |
| Depth | 419 | 16.5 | 464*1 | 18.3*1 |
| **Weights** | **kg** | **lb** | **kg** | **lb** |
| Net | 22.7 | 50.0 | 23.5 | 52.0 |
| Domestic Shipping | 28.5 | 65.0 | 30.4 | 67.0 |
| Export Shipping | 36.3 | 80.0 | 37.2 | 82.0 |

*1 *With handles*

## ORDERING INFORMATION

All 650HR Monitors are shipped with rackmounting hardware. Cabinet version hardware is also included.

| MODEL NUMBER | NTSC | PAL | RGB | PRICE |
|---|---|---|---|---|
| **650HR** | • | | | $5,760 |
| **650HR-1** | • | | • | $5,970 |
| **651HR** | | • | | $6,010 |
| **651HR-1** | | • | • | $6,250 |
| **652HR-1** | | M | • | $6,660 |
| **655HR-1** | • | • | • | $6,925 |

## 656HR-1

**Color Sequencing from Field Identification Signals or Line Burst**

**Precision Decoding Allows Use of R-Y, B-Y Outputs for Vector Display Measurements**

**RGB Inputs with Vector Display Outputs**

**PAL/SECAM with Front Panel Control of Decoding Standard**

**Variable Aperture Correction**

**Vertical and Horizontal Delay Display Modes**

**Reduced Chrominance Line Crawl**

**Indicates Color Sequence Error**

**Rapid Retrace — Entire Picture Area is Displayed in Reduced Scan**

**Two Switchable Inputs Isolated from Ground for Hum Rejection**

The Tektronix 656HR-1 SECAM color picture monitor is identical in function to the other 650HR Series monitors but is specifically designed for use in SECAM systems. It includes both PAL and SECAM decoders.

Color sequencing is front panel controlled by a three position mode switch. In the Field mode, field identification signals are used for color sequencing and a color display is enabled by the presence of detectable field identification signals. In the Line mode, line burst determines color sequence, and a color display is enabled whenever detectable SECAM subcarrier is present. Use of the Monochrome mode blanks the chrominance channel.

In the internally selectable Forced-Color mode, the very high limiting ratio of the chrominance channel lets you use the monitor to search for very small amounts of crosstalk or other unwanted signals. By displaying the chrominance portion of such signals on a brightened display, you can easily identify the source.

Two PROMs (Programmable Read Only Memories) are used in the monitor for generating accurate timing signals. Their use eliminates the need for many internal adjustments and possible drift related to the timing of internal signals. One of these PROMs is programmed with information corresponding to the lines containing subcarrier (including field identification lines) in 625/50 SECAM systems. The monitor then serves as a check on improper additions or deletions of lines that might possibly occur in improperly adjusted VTRs, processing amplifiers, and switchers.

Chrominance line crawl is greatly reduced by using separate acoustical delay lines; one for D'R and one for D'B. With front panel controls, you can turn off luminance or chrominance, and examine each one separately. Brightness is automatically advanced for easier viewing when luminance is turned off for examination of chrominance. For purity checks, you can set up the equivalent of a flat field display by switching luminance off in a monochrome mode (chrominance off).

The monitor's chroma control has two operating modes. When the control is in, the chrominance is independent of subcarrier amplitude. When the control is out, the chrominance is proportional to subcarrier amplitude. In the first mode, the saturation will vary with incoming video level. In the latter mode, correct saturation will be maintained for varying signal levels. In either mode, both a preset (detent) position and a variable range are available. Switching between the two modes in the preset position provides an indication of abnormal chrominance or luminance amplitude.

### CHARACTERISTICS

#### SECAM PERFORMANCE-LUMINANCE CHANNEL

**Bandpass Without Chrominance Trap** — (Aperture Corrector set for 0 dB). Amplitude: ±0.5 dB to 5 MHz. Aperture Corrector Maximum Range: 8 dB; doubled peaked at 2.5 MHz and 7 MHz; ≤3 dB between 4.0 MHz and 5 MHz.

**Chrominance Filter** — Subcarrier Rejection: >25 dB at 4.250 MHz and 4.406 MHz, <−1 dB at 5.5 MHz. NOTE: The chrominance filter is removed from the luminance channel whenever the display is monochrome.

**Pulse Distortion** — <1% tilt on 50 Hz squarewave. <0.5% tilt on 15 kHz squarewave.

**Dc Restoration** — Back porch type, not affected by burst. Mains hum reduction due to dc restorer is <6 dB.

**Amplitude Linearity** — Within 2%.

**Luminance Off Facility** — Displays chrominance only and automatically advances brightness.

#### SECAM PERFORMANCE-CHROMINANCE CHANNEL

**High Frequency De-emphasis** — Matching to Encoder High Frequency Pre-emphasis: Error ≤0.5 dB over the range 3.9 MHz to 4.75 MHz; <3 dB at 2.85.

**Drift (Center Frequency)** — Within ±20 kHz.

**Luminance Rejection** — >46 dB at 15 kHz.

**Limiting Ratio** — >60 dB.

**Ultrasonic Delay Line Error** — <30 ns.

**Crosstalk at Input to Discriminators** — Between Direct and Delayed Chrominance Signals: Alternate line crawl on display is minimized through the use of separate delay lines for the D'R and D'B chrominance signals.

**Discriminator Linearity** — Overall: Within ±1%. Incremental: Within 1%.

**Demodulator Center Frequency** — Clamped to crystal reference stabilized within ±0.250 kHz.

**Chrominance Sequence and Color Enable** — Chrominance sequence and enable are statistically averaged with hysteresis for best performance under poor signal-to-noise conditions. Field Mode: Based upon field identification signals. Chrominance Amplitude: Disable when chrominance is more than 12 dB low, may be internally selected. Line Mode: normally based upon line burst with no chrominance amplitude disable. An internal jumper provides chrominance amplitude disable if required.

**Chrominance Unblanking** — Programmed internally according to 625 line 50 Hz SECAM standards. Field identification signals are displayed in vertical scan delay modes.

**Saturation** — Selectable to treat subcarrier as FM signal or to vary the saturation with incoming chrominance level. Independent of Subcarrier Amplitude: Gain Error <3%. Dependent on Subcarrier Amplitude: Tracking error <5% for signals within ±3 dB to −6 dB of normal amplitude. Chroma Control Separately Adjustable: ±6 dB.

**Cross Talk** — Between R-Y and B-Y >40 dB attenuation.

**Chrominance/Luminance Time Error** — <60 ns with properly adjusted bell filter and low frequency de-emphasis.

**Sequence Error Indicator** — When the front panel red light indicates that the incoming SECAM signal has a chrominance sequence opposite to that indicated by an externally applied 7.8 kHz signal. Also when the monitor is used in the Line mode the light will indicate when the field identification signals are reversed with respect to the Chrominance Sequence present during the active picture.

#### VECTORSCOPE OUTPUTS

**Calibrated Modes (Dots in Boxes)** — Selected by front-panel control for either 75% color bars or 25% color bars (SECAM and RGB only). Vector locations are within ±2% of vector magnitude.

**Vectorscope Drive Capability** — Suitable to drive 10 ft of 75 Ω coaxial cable (unterminated) to X-Y display.

**Required X-Y Display Deflection Sensitivity** — 0.05 V/cm on both X axis and Y axis.

**Required X-Y Display Input Resistance** — ≥100 kΩ.

**RGB Vector Display** — R, G, and B input signals are matrixed to form R-Y and B-Y signals which are switched to the rear-panel vector output connectors when the RGB inputs are selected.

**RGB Matrix Error** — R-Y and B-Y relative output signal amplitudes are within ±2% of desired values when equal R, G, and B signals are supplied.

**RGB Centering** — Black level is clamped to within ±9 mV which corresponds to ±1 mm in the 75% vector display.

**Other Inputs and Outputs** — 7.8 kHz input, 7.8 kHz output, and field 1 pulse output.

#### PHYSICAL CHARACTERISTICS

Same as 650HR on previous page.

### ORDERING INFORMATION

**656HR-1** SECAM + PAL + RGB ..... **$7,740**

## NTSC SIGNAL GENERATOR SELECTION GUIDE

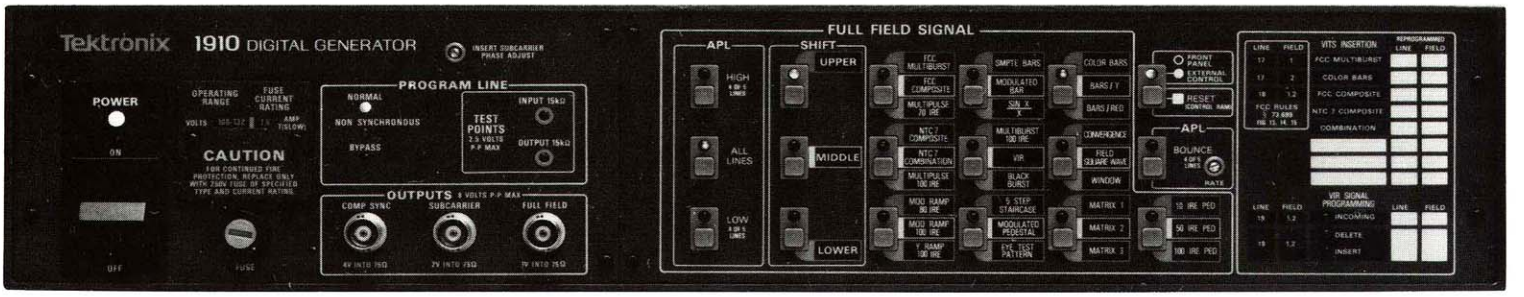
The following guide will help you select the proper NTSC generator to meet your needs. We recommend that you contact your nearest Tek sales engineer for further assistance.

| | | 1410 SERIES | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1910 | TSG7 | TSP1 TSG2 | TSG3 | TSG5 | TSG6 | SPG2 | 1470 | 147A |
| VIRS | •• | | | | | | *4 | | VITS ONLY |
| Full Field Color Bars | •• | • | | | | | | • | |
| EIA Color Bars | • | • | | | | | | | |
| SMPTE Color Bars | • | • | | | | | | | |
| Color Bars/Y Reference | • | • | | | | | | | |
| Color Bars/Red Reference | • | • | | | | | | | |
| Color Bars/Reverse | | • | | | | | | | |
| Luminance Ramp 100 IRE | •• | | | | | | | | |
| Red Field | •• | | | | | | | • | |
| Blue Field | | | | | | | | • | |
| Green Field | | | | | | | | • | |
| Modulated 5-Step Staircase | •• | | | • | | | | • | •• |
| Modulated 10-Step Staircase | •• | | | • | | | | | •• |
| Modulated Ramp 100 IRE | •• | | | • | | | | | *5 |
| Modulated Ramp 80 IRE | •• | | | | | | | | |
| Modulated Pedestal | •• | | | • | | | | | |
| NTC7 Combination | •• | | | | | | | | |
| Composite Test Signal NTC7 | •• | | | | | | | | •• |
| FCC Composite | •• | | | | | | | | |
| Convergence Signal | • | | • | | | | | • | |
| Black Burst | •• | | | | | | • | • | |
| Full/Reduced Amplitude Multiburst | •• | | | | | • | | *3 | •• |
| Frequency Sweep | | | | | | • | | | |
| Sin² Pulse and Bar | | | | | • | | | | •• |
| Sin² Pulse and Window | | | | | • | | | *1 | • |
| Modulated Pulse and Modulated Bar | •• | | | | • | | | | |
| Field Squarewave | • | | | | • | | | | • |
| Noise Measuring Capability | | | | | | | | | •• |
| Flat Field/Variable Level | *2 | | | • | | | | | • |
| APL Bounce (AC) | • | | | • | | | | | • |
| APL Bounce (DC) | | | | • | | | | | |
| Test Signal/Variable APL | • *6 | | | • | | | | | • |
| Multipulse 70 IRE | •• | | | | | | | | |
| Multipulse 100 IRE | •• | | | | | | | | |
| Color Multipulse | •• | | | | | | | | |
| Sin X/X | •• | | | | | | | | |
| Special Multipulse | •• | | | | | | | | |
| MATRIX (PROGRAMMABLE) | THREE | | | | | | | | |
| Digital Signal Generation | • | | | | | | | | |
| Ext VIT Input | FOUR | | | | | | | | ONE |
| Digital Input/Output | •• | | | | | | | | |
| RS-232 Programmability | • | | | | | | | | |
| RS-170A Standard Output | • | • | • | • | • | • | • | | |

A few signals may require reprogramming and some signals may not be available simultaneously.

**Test Signals:**

**1 Window only*
**2 0 IRE,10 IRE,25 IRE,50 IRE,100 IRE*
**3 Reduced only*
**4 As a line 19 signal on the Black Burst output*
**5 90 IRE Ramp*
**6 High or Low*
*• Full-Field Signal*
*•• Full-Field Signal, also available as VITS*




## 1910 Digital Generator

**Four External VITS Inputs for Insertion of Teletext, Closed Captioning, Source ID, etc.**

**Nonvolatile Memory to Maintain Selected VITS and Full Field Signal Configuration after Power Interruption**

**Signal Stored in Replaceable PROMs so Your 1910 won't Become Obsolete**

**The Accuracy and Stability of an all-Digital 10-Bit Sync and Signal Generation (RS-170A)**

**User Friendly RS-232C Control Port for Added Versatility**

**New Signals (Eye Test Pattern, Special Multipulse, Color Multipulse), New Functions (VITS Sequence, Field Sequence and More**

The 1910 Digital Generator is a state-of-the-art test signal generator designed for performance testing of NTSC video systems and equipment. The 1910 is especially suited where high accuracy and stability are required. It is also a VITS inserter (internal and external) with a full complement of signals that allow testing in studio, transmitter, production or research environments. Four external VITS inputs permit insertion of signals such as teletext, closed captioning, source ID, and other similar sources. These four inputs may be converted to four pulse outputs for use in a production environment.

External interfacing of the 1910 is controlled by an internal microprocessor and its nonvolatile memory. Test signals are stored as 10-bit digital words and converted to analog form by a 10-bit precision DAC (with deglitching to reduce differential gain and differential phase) to ensure signal accuracy as well as long term stability and repeatability.

Since all signals are stored in replaceable EPROMs, changing needs and industry standards will not cause obsolescence.

Control and versatility of the 1910 are greatly enhanced by the use of its RS-232 control port. Most functions of the 1910 can be controlled, reconfigured and saved. This includes VITS and full field signal selection, matrix signal creation, sequences and other features.

### Program Line

The 1910 offers full VITS and VIRS insertion capabilities which can be controlled through the RS-232 control port or through ground closures with the remote control unit. The 1910 may be used to insert either internally or externally generated test signals or data patterns in any combination on lines 10 through 21. Full sync and burst insertion capabilities with accurate SCH phasing eliminate the need for proc amps. When used as VITS inserter, the program line is bypassed upon loss of incoming sync to prevent nonsynchronous VITS or sync insertion. The 1910 may be reconfigured so that transmitter protection may be enabled where the loss of incoming sync will automatically cause a test signal to be inserted on the program line to maintain sync continuity until normal operation is restored.

### External VITS Inputs

Four terminated inputs are standard in the 1910. Externally generated VITS from another source such as teletext, source ID, closed captioning, etc. can be internally gated and inserted into the program. External VITS can be inserted on any field of lines 10 through 21 as selected by RS-232 control port or the remote control unit.

### Pulse Out Feature

This included feature of the 1910 allows the user to change the four external VITS inputs to four pulse outputs for limited camera drive. The outputs available are H Drive, V Drive, Composite Blanking, and Burst Flag. Applications for pulse outputs are remote vans or standby sync generators. Composite sync and subcarrier outputs are always available.

The 1910 can also be used as a stand-alone signal source that will remain SCH phased and locked to an internal oven-controlled reference.

### Remote Control

Remote control via a ground closure interface allows the user to control the full field signals, VITS insertion on lines 14 through 21 (VITS changes are saved in nonvolatile memory), VIR mode, bypass/operate, genlock source, control mode and reset to preprogrammed condition.

### Programmability and RS-232 Control Port Features

The 1910 has a friendly command language that allows the user to program its features to meet specific applications. The user does not need to be a programming expert as the 1910 has a language that allows him to concentrate on the applications and not on programming.

The 1910 can be programmed and controlled using an RS-232 terminal. It can also be controlled or run under program control using an RS-232 host computer, including some handheld models or personal computers. The host computer could also be the Tektronix 1980 Automatic Measurement Set which would use the 1910 as a progammable signal source to stimulate and measure television equipment or a transmission link.

The 1910 can also be controlled over telephone lines. An auto-answer modem connected to the 1910 will allow the user to take control of the 1910, observe or modify its status and subsequently release control. The control and reconfiguration can also be accomplished automatically by a host computer.

Some of the capabilities offered by the RS-232 port include the ability to redefine the signal selection on the front panels (1910 and remote control unit) to better meet particular user needs, such as placing frequently used signals in a preferred position or in a convenient sequence for calibration; production testing or other special uses.

### Nonvolatile Memory

The 1910 has an EEPROM nonvolatile memory (no need for battery back up) where configurations different from the factory set can be saved even if the instrument is powered down or a power failure occurs (a nonvolatile memory retains the information stored in it even if the power has been turned off).

**The Following Special Features Are Also Available Through the Control Port:**

### Signal Sequencing

The 1910 has commands that allow the user to program the VITS or full field signals to be displayed for definable periods of time in specific sequences.

Signal Sequence Applications:
An example of color frame sequence would be to set field one to white and the other three fields to black. In this way it becomes simple to identify color field one for an accurate indication of SCH framing. This particular color frame sequence can also test the delay through frame synchronizers, effects generators, etc.

The VITS sequence can optimize the use of the vertical interval by specifying different signals (e.g., test signals, teletext, etc.) for each of the four color fields. One line of the vertical interval can be used to insert up to four signals. These signals may be programmed to change to new signals with the time sequence feature, thus multiplexing many signals onto one vertical interval line.

Sequencing full field or VITS signals provides for manual or automated testing without rquiring operator interaction. It also is useful in generating programmable duty-cycle signals.

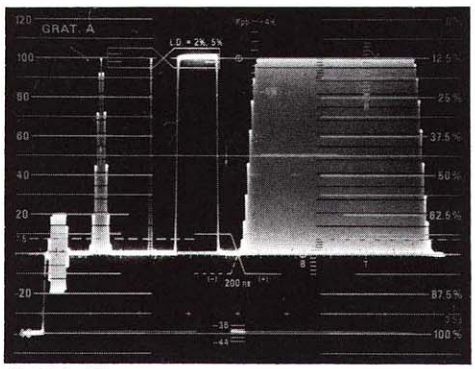
### Digital Word Input and Output

The 1910 features a composite digital parallel data input and output. The digital data output provides a 10-bit digital word of the selected test signal. This highly accurate digital test signal may be used to evaluate and align D to A converters. It's a useful feature as the error incurred in digitizing an analog signal for this purpose is eliminated. The digital data is not modified to compensate for inadequacies in the analog reconstruction process.

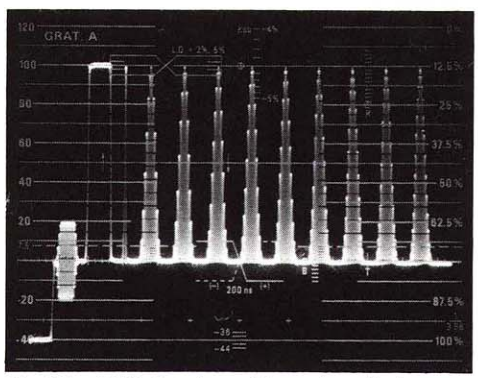
The digital data input will accept a user-generated digital word (up to 10 bits) for conversion to analog with the precision DAC in the 1910. The DAC, with its deglitching circuitry, will yield 10-bit accuracy, 0.6 percent differential gain and 0.3 degree differential phase performance.

### Diagnostics

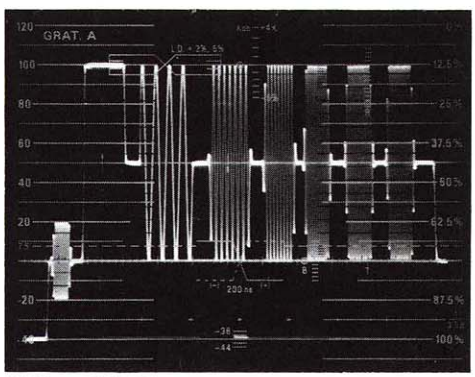
When powering up, the 1910 automatically performs a number of checks to determine if its microprocessor interface is working properly. More extensive internal diagnostics are available for further isolation of faults on an out of service basis.



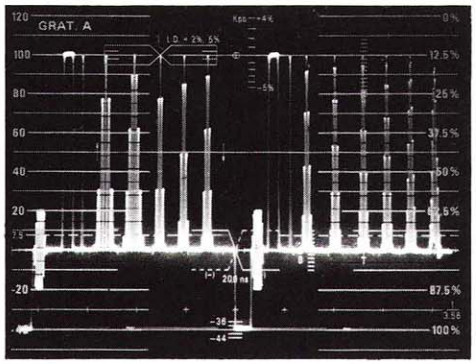

*Modulated Bar*



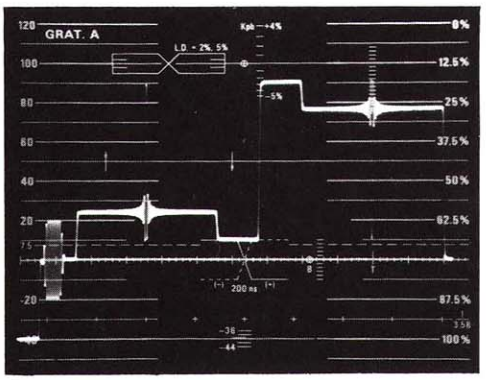

*The Color Multipulse allows delay and amplitude measurements through chroma codecs.*



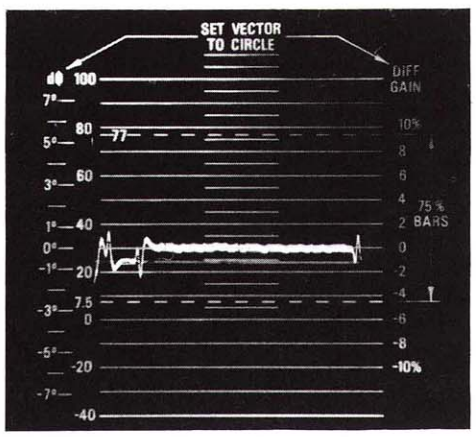

*Multiburst 100 IRE*



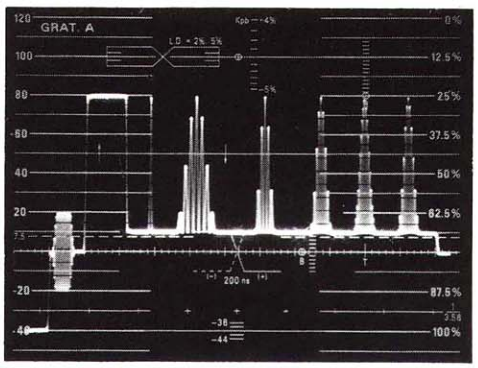

*The Special Multipulse has pulses which extend to 6 MHz allowing delay and amplitude measures past the normal TV channel band edge.*



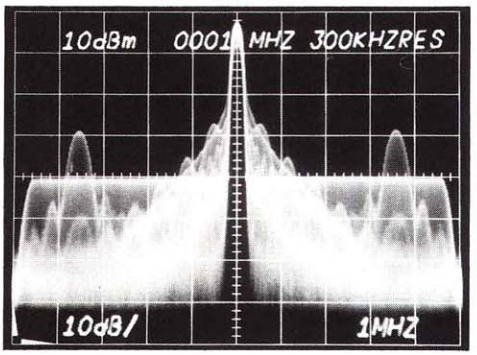

$\frac{Sin\ x}{x}$ *(Time Domain)*



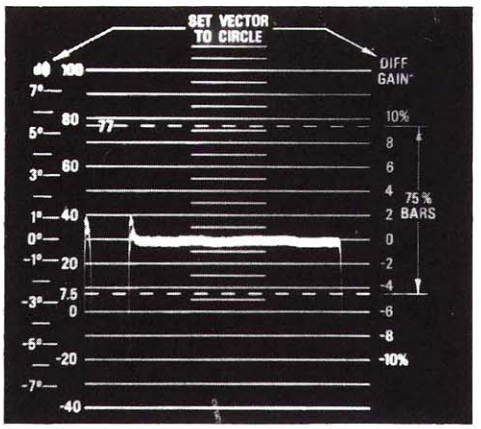

*Modulated Ramp — Differential Phase*




*Multipulse 70 IRE*



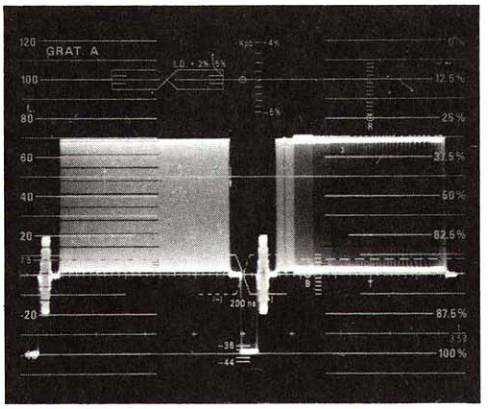

$\frac{Sin\ x}{x}$ *(Frequency Domain)*



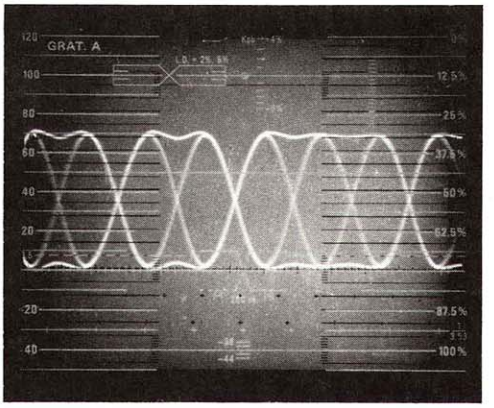

*Modulated Ramp — Differential gain*

## EYE HEIGHT DATA TEST SIGNAL

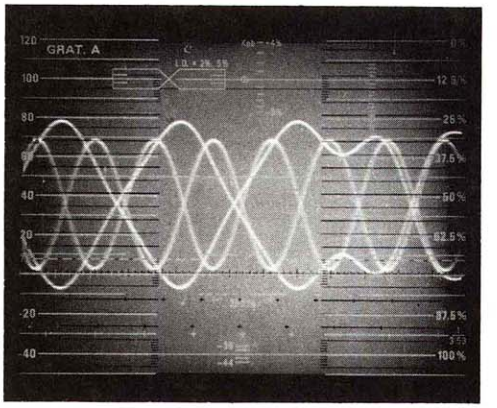
The eye test pattern signal indicates the capability of a system to pass teletext or similar data patterns. Programming the eye test pattern and the eye test reference signals into a VITS or a field sequence allows monitoring for the possibility of data errors. A standard waveform monitor can be used to observe the resulting zero crossings and data height relative to the clock reference.




*Eye test data pattern*




*Data pattern and clock pattern overlaid with no distortion.*




*Same position in signal as last photo but through an uncompensated 4.2 MHz low pass filter. Note the time displacement and the amplitude error closing the data pulses' usable window area.*

## CHARACTERISTICS

### PROGRAM CONTROL SYSTEM VITS INSERTER

**Program Line Input Level** — 1 V ±3 dB (0.7 V to 1.4 V) into 75 Ω.

### PROGRAM LINE/MONITOR OUT

**Impedance** — 75 Ω nominal.

**Hum Rejection** — ≥10 dB (≥20 dB user selectable), referenced to 1 V hum.

**Keyboard (No Noise)** — <0.25 IRE.

**Video Gain** — Unity gain ±0.5%.

**Inserted Pedestal Offset** — 0 V hum: ≤2 mV. 1 V hum: ≤10 mV.

**Pulse to Bar Ratio** — T/2 Pulse to Bar Ratio: 100% ±2%. 1T Pulse to Bar Ratio: 100% ±0.5%. 2T Pulse to Bar Ratio: 100% ±0.25%.

**Frequency Response** — 0.5% to 5 MHz; 1.0% to 10 MHz; 3.0% to 15 MHz.

**Differential Phase (10 APL to 90 APL)** — ≤0.15°.

**Differential Gain (10 APL to 90 APL)** — ≤0.2%.

**Random Noise (Weighted)** — ≥75 dB (RMS) down, referenced to 1 V.

**Spurious Signals During Blanking** — Up to 5 MHz (Insertion Transient): ≥40 dB down (≤10 mV). Above 5 MHz (Clock Noise): ≥46 dB down (≤5 mV).

**Delete Mode Signal Attenuation** — 2T Pulse: ≥70 dB down, referenced to 0.714 V. Subcarrier: ≥60 dB down, referenced to 0.714 V.

**Crosstalk (Internal to Program Line)** — 2T Pulse: ≥70 dB down, referenced to 0.714 V. Subcarrier: ≥60 dB down, referenced to 0.714 V.

### EXTERNAL VITS INPUT

**Insertion Gain** — Unity: ±1% (into 75 Ω).

**Insertion Level** — Dc Coupled: ±2 mV.

**Frequency Response** — Flat within 1% to 5 MHz.

**Pulse to Bar Ratio** — 2T: 100% ±1%. 1T: 100% ±2%.

**External Input Isolation** — >60 dB to 5 MHz.

**Switching Transients** — <10 mV p-p to 5 MHz.

### GENLOCK

**Source** — Program Input or Black Burst Input.

**Sync or Burst Amplitude** — 40 IRE ±6 dB.

**Burst Lockup Range** — 3.579545 MHz ±20 Hz (sync must be locked to burst).

**Sync Lockup Range** — 15.73426 kHz ±0.079 Hz.

**Free Run Frequency** — 3.579545 MHz ±10 Hz. Temperature controlled, four times subcarrier oscillator normally locked to burst, or sync when burst absent.

**Jitter** — <5 ns (free run and burst lock mode).

### FULL FIELD OUTPUT

### TIMING

All signal components (pulses, transitions and sinewaves) are digitally generated. The position of these components are repeatable between 1910s to better than 10 ns. The frequency accuracy of any sinewave depends on a master 14.31818 MHz oscillator. Timing of sync and burst is to EIA RS-170A specifications.

**Line Blanking Width** — 11.5 μs ±100 ns at 50% amplitude points (measured on 100 IRE Ped).

**Front Porch Width** — 1.8 μs ±100 ns at 50% amplitude points (measured on 100 IRE Ped).

### GENERAL

**Output Impedance** — 75 Ω nominal.

**Dc Level** — 0 V ±2 mV (Clamp On); 0 V ±50 mV (Clamp Off).

**Luminance Gain** — Within ±1%. All luminance levels are digitally defined and will be within ±0.5 LSB (±1.3 mV or ±0.2 IRE) of the correct value relative to the calibrated 100 IRE level.

**Chroma Amplitude Accuracy** — Within ±0.72% (adjustment accuracy) plus quantizing error.
Definition of Quantizing error = $\frac{40 \text{ IRE} \times 0.6\%}{\text{chroma amplitude}}$

**Relative Frequency Flatness** — ±0.3% typical from 56 kHz to 5 MHz with 0.714 mV p-p (digital sweep generator and p-p detector). ±1% maximum using 50 IRE Multiburst (500 kHz to 4.2 MHz).

**Differential Phase** — ≤0.3° using 100 IRE Mod Ramp with 40 IRE p-p subcarrier.

**Differential Gain** — ≤0.6% using 100 IRE Mod Ramp with 40 IRE p-p subcarrier.

**2T Pulse to Bar Ratio** — 100% ±1%.

**2T Pulse Ringing** — ≤1 IRE p-p.

**Group Delay Error** — ≤10 ns, up to 5.0 MHz.

### FULL FIELD AND VITS SIGNALS

### TEST SIGNAL SPECIFICATIONS

**FCC Multiburst and Multiburst 100 IRE** — Frequencies: 0.5 MHz, 1.25 MHz, 2.0 MHz, 3.0 MHz, 3.58 MHz and 4.1 MHz.

**NTC 7 Combination** — Frequencies: 0.5 MHz, 1.0 MHz, 2.0 MHz, 3.0 MHz, 3.58 MHz and 4.2 MHz. Chroma: 20 IRE, 40 IRE, 80 IRE at 90°.

**Multipulse 100 IRE** — Frequencies: Same as NTC 7 Combination without 0.5 MHz.

**Multipulse 70 IRE** — All pulses on a 10 IRE pedestal. Frequencies: Same as FCC Multiburst without 0.5 MHz.

**Color Multipulse** — Subcarrier frequency for center pulse. Pulses to the left are decreasing in frequency by 300 kHz increments while pulses to the right are increasing in frequency by 300 kHz.

**Special Multipulse** — Frequencies: 1 MHz through 6 MHz at 500 kHz increments.
NOTE: This signal uses two adjacent lines.
$\frac{\text{Sin } x}{x}$
Spectrum: −3 dB at 4.75 MHz. Positive and negative pulses.

**FCC Composite** — 80 IRE staircase.

**NTC 7 Composite** — 90 IRE staircase.

**Ramp (100, 80)** — Luminance: 100/80 IRE. Chroma: 40 IRE at 180°.

**Staircase (5 Step, 10 Step)** — Luminance: 100 IRE. Chroma: 40 IRE at 180°.

**Inverted Pulse and Bar** — Positive and negative 2T pulses.

**Modulated Bar** — Chroma: 100 IRE at 33°.

**Modulated Pedestal** — Chroma: 20 IRE, 40 IRE, 80 IRE at 90°.

**Color Bars, Y Bars** — 75% amplitude, 7.5% setup, 6.5 μs/bar (8 bars).

**Red Field** — 75% amplitude, 7.5% setup.

**Bars/Y** — Split field of Color Bars followed by Y Bars.

**Bars/Red** — Split field of Color Bars followed by Red Field.

**EIA Bar** — 75% amplitude, 7.5 setup, 7.5 μs/bar (7 bars). SMPTE compatible.

**IYQB (with PLUGE)** — SMPTE compatible.

**Reverse Blue Bars** — Blue component of EIA Bar. SMPTE compatible.

**SMPTE Bars** — Split field of EIA Bar, Reverse Blue Bars, and IYQB.

**VIRS** — Luminance: 70 IRE, 50 IRE, 7.5 IRE. Chroma: 40 IRE at 180°.

**VICR*[1]** — Luminance: 50 IRE, 100 IRE, 7.5 IRE. Chroma: 100 IRE at 180°.

**Convergence** — 14 x 17 crosshatch with dots.

**APL, Bounce, Black Burst (7.5), 10 IRE, 25 IRE, 50 IRE and 100 IRE Ped** — Full line width.

**Field Bar** — 100 IRE. 18 μs wide.

**Field Squarewave** — Same as 100 IRE Pedestal.

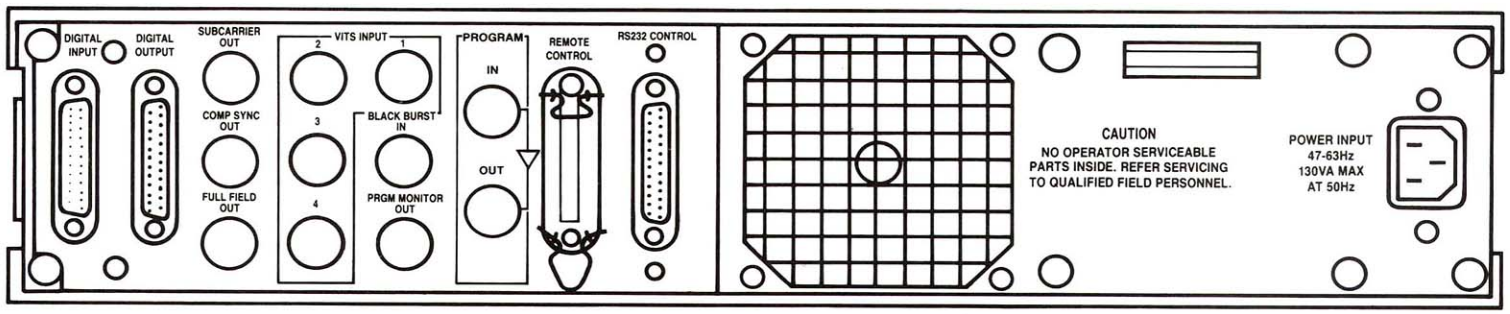
**Window** — Same as Field Bar.

**Eye Test Pattern** — Test pattern at 5.7 Mbit/s. Risetime: 100 ns.

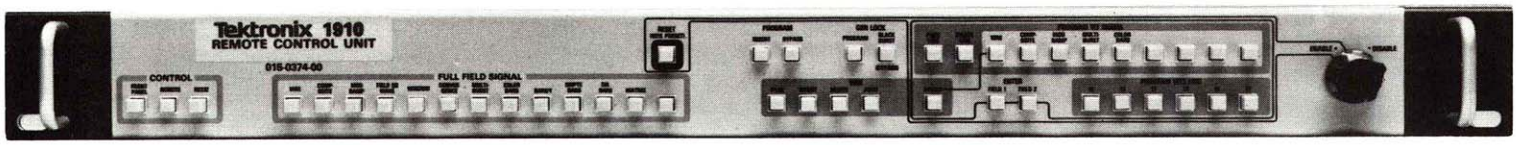
**Eye Test Reference** — Alternate "1", "0" pattern at 5.7 Mbit/s. Risetime: 100 ns.

**Matrix (Factory Set, but User Redefinable)** — Matrix 1: Mod 10 Step, Color Bars, Red Field. Matrix 2: Mod Ramp 100 IRE, EIA Bar, Reverse Blue Bar, Multipulse 100 IRE. Matrix 3: Convergence, EIA Bars, Reverse Blue Bar, Convergence, IYQB, Convergence.

*[1] Vertical interval color reference.*




*1910 Rear Panel*




*1910 Remote Control Unit*

### SYNC AND SUBCARRIER OUTPUT

All pulse outputs have negative going output levels of 4 V ±10% into 75 Ω and have a risetime and falltime of 140 ns ±20 ns.
**Composite Sync Timing** — EIA RS-170A Specifications.
**Subcarrier Output** — Frequency: See Genlock. Amplitude: 2 V p-p ±10%.
The following optional outputs replace the external VITS input function of the 1910.
**Composite Blanking** — Horizontal Blanking Width: 10.7 μs ±100 ns. Field Blanking: Field 1=21 lines, Field 2=21 lines.
**Horizontal Drive Timing** — Start of line blanking to end of line sync, ±100 ns.
**Vertical Drive Timing** — Coincident with start of field. Duration: 9 lines.
**Burst Flag** — Duration: 2.5 μs ±100 ns. Delay from Line Sync: 5.3 μs ±100 ns.

### RS-232C INTERFACE

Supports EIA Standard RS-232C format to the extent shown below.
**Baud** — 300 bit/s, 1200 bit/s, 2400 bit/s or 4800 bits/s.
**Input/Output** — ASCII, serial, asynchronous data. Full duplex input and output.
**Character Length** — Eleven bits/character, including a start and two stop bits.
**Parity** — Input: No parity required and, if present, is ignored. Output: No parity sent.

### DIGITAL DATA INTERFACE

Parallel, 12 balanced, signal pairs consisting of 10 bits/sample, a clock, a timing reference signal.
**Sampling Frequency** — Four times color subcarrier. Nominally 14.3 MHz.
**Sampling Phase Angle** — Referenced to I axis and Q axis.
**Dynamic Range** — Ten bits/sample: Blanking level (0 IRE) is at digital word 240. Reference white (100 IRE) is at digital word 800 (5.6 LSB/IRE).
**Input Logic Levels Terminated in 100 Ω** — 10 k ECL compatible.
**Output Logic Levels** — 10 k ECL compatible.
**Digital Input Timing** — Setup and hold times are 10 ns before and after the 50% point of the negative transition of the clock.
**Output Clock Timing** — The 50% point of the leading edge of the clock pulse preceeds the data by 5 ns ±5 ns.

### POWER SUPPLY

**Line Voltage Range** — 90 V ac to 132 V ac. 180 V ac to 250 V ac.
**Maximum Power Consumption** — 130 W.
**Line Frequency** — 47 Hz to 63 Hz.

### PHYSICAL CHARACTERISTICS

| | Cabinet | | Rackmount | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 442 | 17.4 | 486 | 19.1 |
| Height | 96 | 3.8 | 88 | 3.5 |
| Depth | 525 | 20.6 | 525 | 20.6 |
| **Weight** | **kg** | **lb** | **kg** | **lb** |
| Net | 11.6 | 25.5 | 12.2 | 27.0 |
| Shipping | 16.7 | 37.0 | 16.7 | 37.0 |

### ENVIRONMENTAL CHARACTERISTICS

**Temperature** — Operating: 0°C to +50°C. Nonoperating: −40°C to +65°C.
**Altitude** — Operating: To 4572 m (15,000 ft). Nonoperating: To 15 240 m (50,000 ft).
**1 Vertical interval color reference*

### INCLUDED ACCESSORIES

Pair of rack slides (351-0636-00); pulse out board (670-8007-00); cabinet hardware; rack hardware; operator manual; service manual.

### ORDERING INFORMATION

**1910** Digital Generator ..... **$9,990**
**Option 03** — CBC Test Signals ..... **NC**

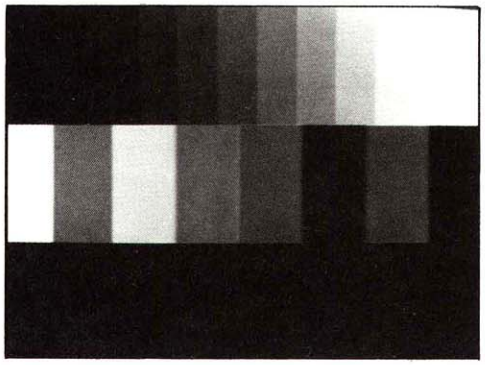
### OPTIONAL ACCESSORIES

**Remote Control Unit**
Order 015-0374-00 ..... **$400**
**Interconnecting Cable (6 ft).**
Order 012-0108-00 ..... **$150**
**Interconnecting Cable (22 ft).**
Order 012-0251-00 ..... **$350**

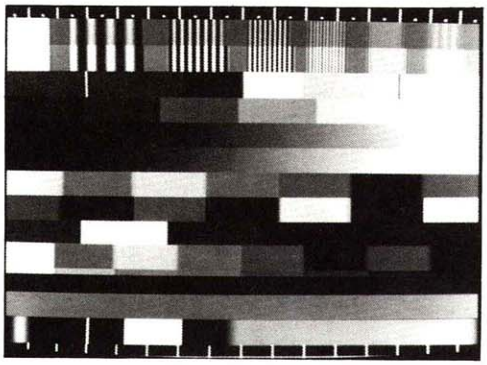
## SIGNAL MATRIXING

The matrix feature of the 1910 divides the field into 16 blocks of lines consisting of approximately 16 lines each. Through the RS-232 control port the user can program any full field signal to appear in any of the 16-line blocks. Any signal can be repeated in as many blocks as necessary. There are three matrix signals in the 1910 that are factory set, but can be user-redefined and saved in a nonvolatile memory.

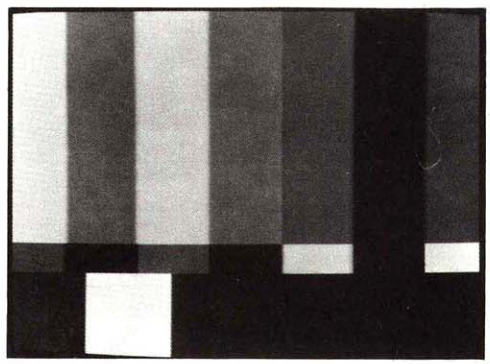
Some of the applications of this feature include user-defined tape headers or monitor test patterns. The matrixed signal can serve several users simultaneously, reducing the need for multiple signal outputs. By using the 15-line feature of the Tektronix 1480-Series Waveform Monitors, particular signals in the matrix can be viewed by the users.



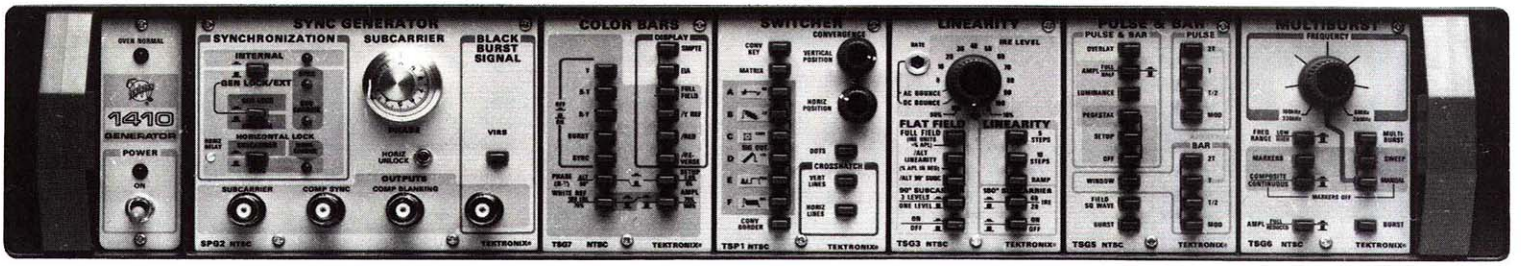
*Matrix composed of modulated stairstep, full field bars and red field.*



*An arbitrary test pattern showing all 16 blocks of the signal matrix capability, used by as many test signals.*



*SMPTE color bars test signal made up using the 1910 signal matrixing feature. (SMPTE bars are also available on the front panel as a standard signal).*




*1410R Option 04 Test Signal Generator*

## 1410R NTSC/1411R PAL/ 1412R PAL-M

**Five Test Signal Generators and One Switcher**

**Conforms to EIA Standard RS-170A (1410R)**

**Sync to Subcarrier Phasing Maintained or Corrected**

**Color Frame Reference Output**

**Genlock to Composite Video**

**Lock to External References**

**Adjustable Blanking Widths**

**Adjustable Sync Delays (H and V)**

**Broadcast Quality**

The 1410R Series sync and test signal generators are precision generators for use in studios, remote vans, maintenance facilities and anywhere high quality sync or test signals are required.

Three different models are available. The 1410R is for NTSC applications, the 1411R for PAL and the 1412R is for PAL-M applications.

Each 1410R Series generator includes a genlock sync pulse generator. Five different test signal generators (four for PAL-M) and one signal switcher are available for each color standard (NTSC, PAL, PAL-M). Any combination of up to five test signal generators and signal switchers can be installed in one mainframe. The following components are available for each color standard.

**1410R SERIES PRODUCTS**

| | Color Standard | | |
|---|---|---|---|
| Description | NTSC | PAL | PAL-M |
| Mainframe | 1410R | 1411R | 1412R |
| Sync Pulse Generator | SPG2 | SPG12 | SPG22 |
| Color Bars Generator | TSG7 | TSG11 | TSG21 |
| Convergence Generator | TSG2 | TSG12 | |
| Linearity Generator | TSG3 | TSG13 | TSG23 |
| Pulse & Bar Generator | TSG5 | TSG15 | TSG25 |
| Multiburst Generator | TSG6 | TSG16 | TSG26 |
| Signal Switcher | TSP1 | TSP11 | TSP21 |

The 1410R Series generators may be ordered with standard combinations of signal generators or they can be configured to your specific requirement. A 1410R Series generator can be ordered with a minimal complement of signal generators now and others added later as your needs grow.

1410R Series test signal generators begin on page 169. If further assistance is needed contact your local Tektronix Television Sales Engineer.

*Unless otherwise indicated by a statement enclosed by parentheses ( ), all information characteristics and descriptions of the 1410R NTSC Series and its generators applies equally to equivalent mainframes or generators for the 1411R PAL and 1412R PAL-M Series. Information in parentheses applies only to the specified series.*

## SYNC PULSE GENERATORS

The SPG2, SPG12 and SPG22 are high quality sync generators designed for use in systems where accuracy, stable SCH (sync-to-subcarrier) phasing capability, and lockup mode versatility are of prime importance.

Two external synchronization modes, external reference and genlock, are available. In the genlock mode, line field, subcarrier, and PAL pulse (SPG12, SPG22) timing are derived from the incoming composite video signal.

In the external reference mode, line, field, subcarrier, and PAL pulse timing is derived from individual reference signals applied to the generator.

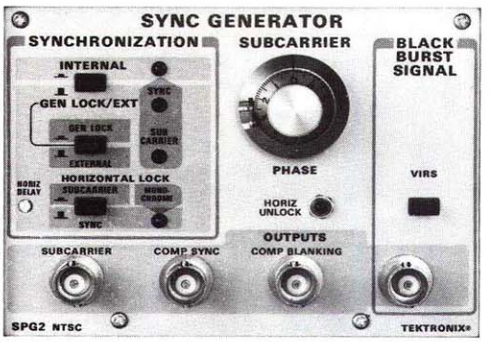
The SCH phasing can be set or maintained at any offset. This is made possible by locking the generator color subcarrier to the reference color subcarrier and referencing generator-line and field-sync-signal timing to subcarrier rather than line and field sync on the incoming reference signals. This feature is of value in editing and program assembly applications. A color frame identification pulse output identifies Field 1 of the color field sequence. Should the user desire, the SCH phasing feature of the sync pulse generator can be disabled with a front panel control. In this mode of operation the SCH phasing of the incoming signal is maintained by locking subcarrier to incoming burst or subcarrier, sync to incoming sync.

A slow genlock mode is provided for those applications where fast-lock may upset the system. The slow-lock selector is located on the generator card sets.

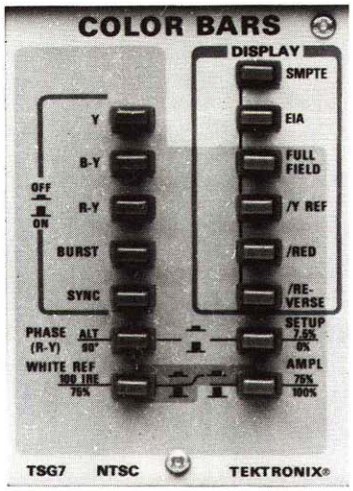
Genlock or external reference lock mode selection may be remotely controlled. Remote manual phasing of the SPG12 or SPG22 signal to an external source is possible in the internal mode. Vertical and/or horizontal timing are altered as in slow-lock operation. Front panel LED's are used to indicate generator lock status.

Internal adjustments permit some variation of burst and blanking widths on the burst flag, comp blanking, and black burst outputs. These adjustments are preset to conform to recognized standards. You can reduce widths initially to allow for the widening that sometimes occurs when the video signal is processed.

The subcarrier frequency accuracy is ±1 Hz when operated in the internal mode. An optional ±10 Hz oscillator (Option 10) is available for the 1410R. A black burst output independent of all other outputs is provided. For NTSC systems, the VIRS (Vertical Interval Reference Signal) is factory programmed on line 19, Field 1 and Field 2 of the black burst when selected by a front panel switch on the SPG2. VIRS can be selected on line 18 if desired.




*SPG2 Genlock Sync Generator*




*TSG7 Color Bars Generator*

## TSG7/TSG11/TSG21

### Color Bars Generators

**Color Bars Signals**

**SMPTE Color Bars (TSG7)**

**EIA (TSG7)**

**Fixed Full Field (TSG11/TSG21)**

**Full Field with Switchable Components**

**75% or 100% Amplitude**

**Split Field/Y Reference**

**Split Field/Red**

**Split Field Bars/Bars Reversed**

The TSG7, TSG11 and TSG21 provide high-quality full field and split field color bars for the 1410R Series signal generators. The TSG7 operates independently from any other test signal installed in the mainframe. Its output is available simultaneously with all other test signal outputs. The composition of the signal can be altered by switching off Y, B-Y (U), R-Y (V), Burst, and Sync.

You may also select fixed or alternating R-Y (V) subcarrier phase, bar amplitude, white reference, and setup level (or pedestal).

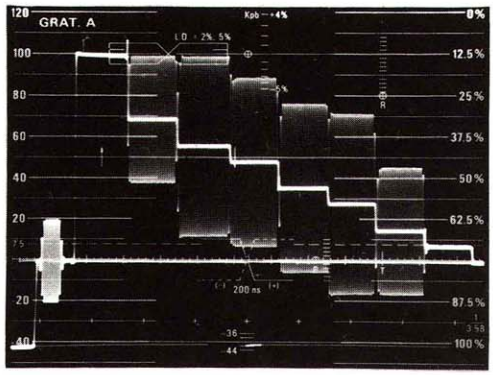
The /Y REF switch selects a split field display of color bars in the same sequence as full field, followed by the luminance portion of the color bars for the remainder of the field. The split can be 1/2 or 3/4 field as selected by internal programming in the sync pulse generator. With this signal, you can check chrominance to luminance delay and picture monitor gray scale tracking while simultaneously evaluating color performance.

The /RED switch selects a split-field display of color bars, as in /Y REF, followed by red chrominance. (Same phase and amplitude, and at the same luminance level as the red bar.) Use this signal for adjusting VTR playback controls. Head equalization errors and noise are easily spotted on a red field. Other bar colors can be chosen by internal programming. The signal is also remotely switchable to color bars/white.

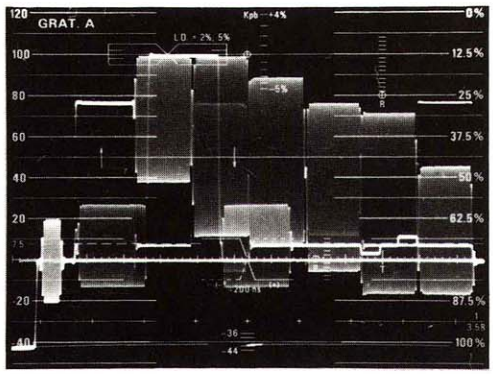
The /REVERSE switch selects a split field display of color bars as in /Y REF, followed by color bars in a reverse sequence. That is black, blue, red, magenta, green, cyan, yellow, white. This signal helps detect chrominance to luminance delay while viewing the kinescope of a color monitor/receiver. Reverse bars are also useful in detecting VTR velocity errors.

The TSG7 will produce color bars VIT on any VIT line desired. (VIT signals cannot be inserted on the program line. Use a 147A, 148, 148M, or 1910 for insertion of VITS on a program line.)

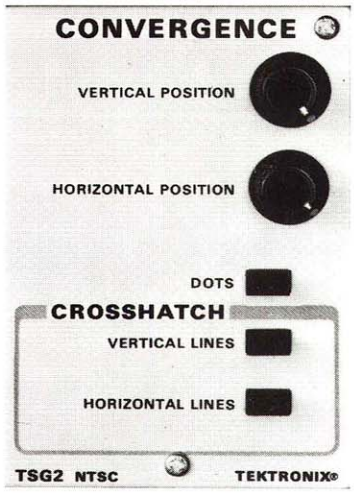
The SMPTE switch (TSG7) is used to select the alignment color bar test signal for television picture monitors. This signal is generated in accordance with the format outlined in SMPTE Engineering Committee Recommendations, ECR 1-1978. SMPTE bars provide an easy way to objectively adjust picture monitor chroma, hue, and brightness.




*Color Bars/Y Reference*




*SMPTE Color Bars*




*TSG2 Convergence Generator*

## TSG2/TSG12

### Convergence Test Signal Generators

**Dots and Crosshatch**

**Dots Only**

**Vertical Lines Only**

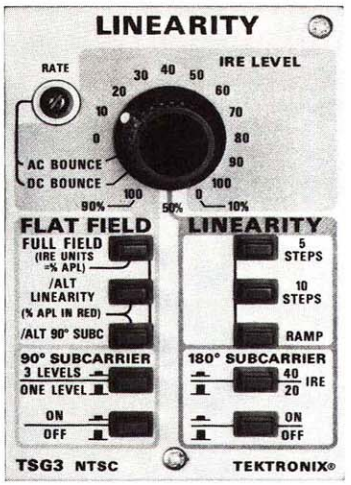
**Horizontal Lines Only**

**Vertical and Horizontal Lines**

**Position Controls**

The TSG2 and TSG12 provide high-quality convergence test signals for the 1410R Series signal generators. You can use them to determine picture monitor or camera scanning linearity, aspect ratio, and geometric distortion. Signals for the TSG2 conform to IEEE Standard 202.

Provision is made for on/off switching of the dots, vertical lines, and/or horizontal lines and for positioning vertical and horizontal lines. The signal output is located on the rear panel of the mainframe in which the test signal generator is installed. The convergence signal output is available simultaneously with all other test signal generator outputs.




*TSG3 Linearity Signal Generator*

## TSG3/TSG13/TSG23 Linearity and Modulated Pedestal Test Generators

**5 Step and 10 Step Staircase Signal Ramp Signal**
**2 Modulation Amplitudes**

**One or Three Level Modulated Pedestal**

**Flat Field with 11 Fixed Levels**

**Ac and Dc Bounce**

The TSG3, TSG13 and TSG23 provide high-quality linearity and modulated pedestal test signals for the 1410R Series signal generators.

Combine variable APL with either of these signals to measure nonlinear distortions. The generators operate independently of all other test signal generators installed in the mainframe, while the rear panel output is available simultaneously with all other test signal generators' outputs.

You can select the 5 step and 10 step staircase signals and the ramp signal with or without 180° subcarrier modulation for NTSC, or U subcarrier modulation for PAL and PAL-M. The subcarrier amplitude is front panel selectable at 20 IRE or 40 IRE on the TSG3, or at 140 mV and 280 mV on the TSG13 and TSG23. Applications include measuring differential phase and gain, dynamic gain, luminance linearity, and burst phase errors.

With the TSG3, the flat field signal can be used on all active picture lines with levels set by the IRE Level control (% peak white on the TSG13, TSG23) or flat field on four lines can be alternated with one line of linearity or modulated pedestal. When using the alternate mode APL is controlled by the IRE level control (% peak white on the TSG13, TSG23).

The ac Bounce position of the IRE level switch (TSG3) or the % peak white switch (TSG13, TSG23) provides a signal in which the active portion of each line (excluding sync) changes APL levels at a rate determined by the rate control (1 second to 30 second intervals).

For the TSG3, amplitude of the bounce excursions is fixed at 0 IRE to 100 IRE in flat field mode and 10% to 90% APL in alternate modes. Blanking level remains fixed at 0 V. To check ac coupled circuitry use ac bounce.

With the switch set to dc bounce, ac bounce occurs as described above. In addition, the entire signal changes dc level in the opposite direction at the same rate resulting in no change in average dc level. Clamp circuits may be checked using dc bounce.

## TSG5/TSG15/TSG25 Pulse and Bar Generators

**Pulse and Bar Overlay**

**Full and Half Amplitude Pulse and Bar**

**Field Squarewave and Window**

**Modulated Pulse and Modulated Bar**

**Front Panel Selection of 2T, T, and T/2 Pulse Width and Bar Risetime**

The TSG5, TSG15, and TSG25 are sin² pulse and bar television test signal generators designed for use with the 1410R Series signal generators. They're well suited for testing on equipment manufacturers' production lines and for testing of television transmitters, common carrier microwave and wire lines, and studio distribution systems. Front panel controls provide most test signal options, while internally selectable options provide additional versatility.

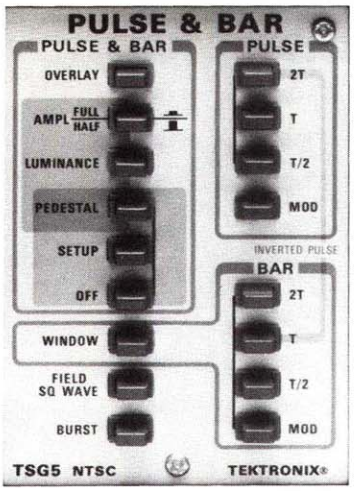
The pulse and bar test signal consists of a sin² modulated pulse, a sin² pulse, and luminance bar. The pulse and bar overlay mode lets you conveniently compare pulse to bar ratio without manipulating waveform monitor controls.

The inverted and noninverted 2T pulses may be overlaid to compare shape and HAD (half amplitude duration). This capability is particularly useful in detecting quadrature distortion which results from envelope detection of the RF modulated video signal. The pulse and bar test signal is also useful in measuring line time and short time distortions.

For sin² pulse signals, three self-cancelling switches permit independent selection of pulse half amplitude duration (2T, T, T/2) independent of bar risetime. In the bar mode, four self-cancelling switches permit selection of luminance bar risetime (2T, T, T/2) or modulated bar.

Full or half amplitude pulse and bar test signals can be provided with or without pedestal or setup (the TSG15 and TSG25 do not offer setup capability). For the TSG5, full amplitude is 100 IRE units with no setup. Half amplitude is 50 IRE with no setup. For the TSG15 and TSG25, full amplitude is 100% (700 mV) with no setup. Half amplitude is 50% (350 mV) with no setup.

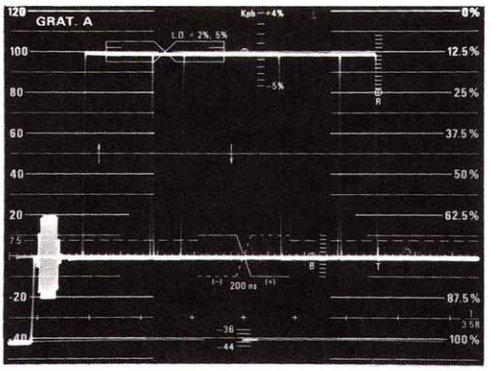
The luminance pulse, luminance bar, and luminance components of the modulated pulse and modulated bar may be switched off to provide chrominance pulse and chrominance bar. The chrominance pulse and bar may be placed on a pedestal (50 IRE for the TSG5, 50% for the TSG15 and TSG25) to prevent chrominance from extending below blanking level.



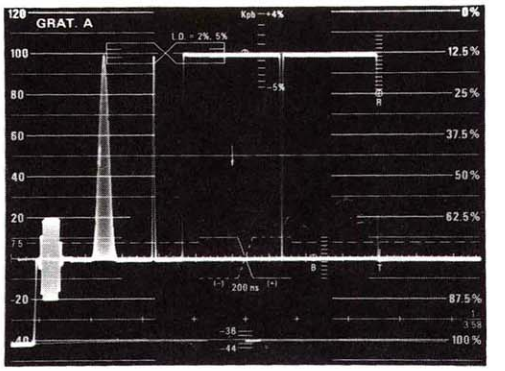

*TSG5 Pulse and Bar Signal Generator*

Use the standard field squarewave (with full amplitude and no setup) to measure field time distortion, and the window signal to measure line time distortion and picture monitor smearing. You can switch the color burst off without affecting the chrominance components of the test signals.

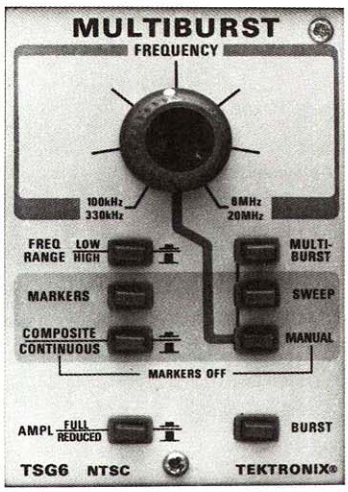
Use the TSG5 for measuring overall gain, transient response, line and field time tilt, and chrominance to luminance delay and gain.




*Pulse and Bar Overlay*




*Sin² Pulse and Bar with Inverted Pulse*




*TSG6 Multiburst Signal Generator*

## TSG6/TSG16/TSG26

### Multiburst Signal Generators

**Multiburst Signal**

**Controlled Risetime Burst Packets**

**Last Burst Frequency Variable**

**Manual and Field Swept Frequency Signals to 20 MHz**

**Markers for Both Frequency and Amplitude Reference**

**Full and Reduced Amplitude on all Signals**

The TSG6, TSG16 and TSG26 are television multiburst and video sweep test signal generators designed for the 1410R Series signal generators.

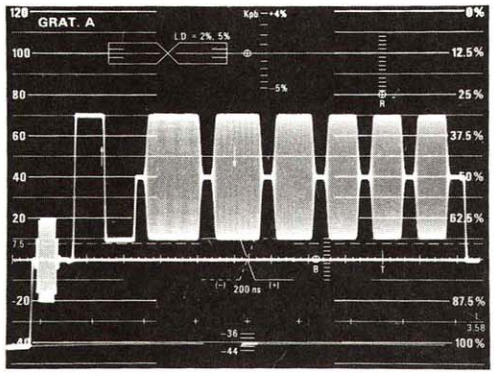
They feature front panel controls for most test signal options, plus special Remote functions for additional versatility. They can be used in many testing applications, including equipment manufacture and microwave or long-line transmission systems.

Performance advances include reduction in harmonic content of sinewave signals and skirt energy associated with gating burst packets. Phase modulation of the burst packets aids ease of measurement by filling in shape of packets. Two ranges of multiburst frequencies are available: the 500 kHz to 4.1 MHz (TSG6) range aids in testing television transmitters and common carrier links, while the 1.25 MHz to 12 MHz range is used in testing television studio equipment and cabling.

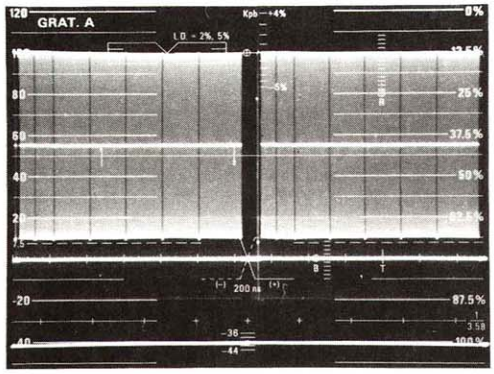
Use these generators where nonlinearities make reduced amplitude test signals desirable. The reduced amplitude multiburst signal allows accurate testing of video tape record/playback systems, since it is not subject to the false distortion of the full amplitude multiburst that often occurs in such applications.

Using the front panel controls, you can select a high or low-frequency band for each operating mode. SWEEP, allows selection of field sweep signal with or without markers. MARKERS inserts amplitude/frequency markers in Sweep, and amplitude markers in Composite/Manual. BURST allows insertion/deletion of color burst on composite video for use with systems that operate differently when burst is present. COMPOSITE/CONTINUOUS determines whether sync, blanking, and a pedestal will be added to the sweep and manual signals.

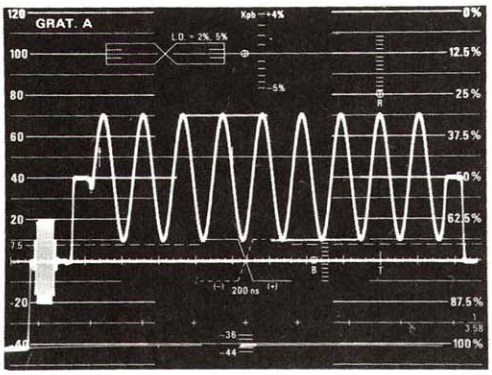
MANUAL selects a fixed-frequency sinewave with frequency determined by the Frequency control and Frequency Range switch. AMP allows selection of either full or reduced amplitude in all operating modes, MULTIBURST selects line-rate discrete-frequency packets with reference insertion levels.



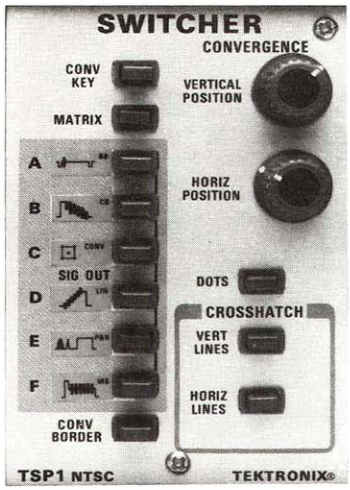

*Reduced Amplitude Multiburst*




*Field Rate Sweep showing amplitude and frequency markers*




*Line Rate Display of manually selected frequency Showing Amplitude Marker*




*TSP1 Signal Switcher*

## TSP1/TSP11/TSP21 Switchers and Convergence Generators

**Single Switchable Output for Two to Six Generated Signals**

**Blanking, Sync and Burst Insertion for External Signal**

**Matrixing—Eight Programmed Display Formats to up to Six Sequential Signals**

**Convergence Border**

**Convergence Key**

**Crosshatch or Dots**

**Combined Crosshatch and Dots**

The TSP1, TSP11, and TSP21 combine the capabilities of a test signal switcher and convergence signal generator in a single unit. They simplify and expand the uses of the 1410R Series signal generators.

From a single, electronically switched output, you have access to all the test signals (from two to six) generated by the card sets in the mainframe. Meanwhile, you may continue to use the individual generator card sets' parallel outputs, so no restrictions are imposed on an established system. As an added feature, one of the input signals can be external (composite or noncomposite). All of the switcher inputs are provided with clamp circuitry.

Eight different matrixes are stored in the PROM. This signal matrixing capability, combined with the full-field mode of the TSP1 presents several combinations of signals sharing the full field display.

Most of TSP1 switching functions can be remotely controlled through the mainframe's Remote connector.

## CHARACTERISTICS

### SYNC PULSE GENERATORS

**1410R Subcarrier** — Frequency (Fsc): 3.579545 MHz ±1 Hz. Pull-in Range: Fsc ±20 Hz.

**1410R Option 10 Subcarrier** — Frequency (Fsc): 3.579545 MHz ±10 Hz. Pull-in Range: Fsc ±50 Hz.

**1411R Subcarrier** — Frequency (Fsc): 4.43361875 MHz ±1 Hz. Drift ≤1 part in $10^7$ per week. Pull-in Range: Fsc ±20 Hz.

**1412R Subcarrier** — Frequency (Fsc): 3.57561149 MHz ±1 Hz. Drift ≤1 part in $10^7$ per week. Pull-in Range: Fsc ±20 Hz.

### PULSE OUTPUTS

**Output Level (Into 75 Ω)** — 4 V (1410R), 1 V, 2 V, or 4 V (selectable, 1411R and 1412R) ±0.2 V.

**Return Loss** — ≥30 dB to 5 MHz.

**Risetime and Falltime** — 10% to 90% (Linear Ramp). 140 ns, (1410R, 1422R). 250 ns (1411R-Other values internally selectable).

**Jitter** — Linelock: ≤10 ns. Subcarrier Lock: ≤4 ns.

**Composite Sync** — Equalizing Pulse Duration: 2.3 μs (2.38 μs-1412R) ±100 ns. Field Sync: Duration 27.0 μs ±200 ns (27.2 μs ±100 ns-1411R). Interval Between Field Sync Pulses: 4.77 μs (4.8 μs-1411R, 1412R) ±100 ns. Line Sync Duration: 4.7 μs ±100 ns.

**Comp Blanking** — Line Blanking Duration: 10.7 μs (12.0 μs-1411R, 11.1 μs-1412R) nominal, adjustable 9 μs to 12 μs. Field Blanking Duration: 20 lines (25 lines-1411R, 21 lines-1412R) nominal, adjustable 16 lines to 21 lines (16 lines to 25 lines-1411R).

**Burst Flag** — Delay from Line Sync: Adjustable. Duration: 2.51 μs ±50 ns (2.25 μs ±100 ns-1411R) adjustable.

**Horizontal Line Drive** — Duration: Start of line blanking to end of line sync ±100 ns.

**Vertical Drive** — Duration: 9 lines (1410R, 1412R) 7½ lines (1411R).

**Field REF** — Position: Field 1, line 11 or Field 3, line ten (internally selectable 1410R); Field 1 line 7 (1411R); Field 1 line 8 (1412R).

**PAL Pulse, Phasing (1411R, 1412R only)** — Negative transition coincident with leading edge of line sync on either +V or −V lines. Factory set to +V. Duration: 4.7 μs, within 0.2 μs. Level: 2 V 75 Ω at H/2 Rate.

**PAL Pulse Squarewave (1411R, 1412R only)** — May be internally selected in place of pulse. Level: 1 V, 75 Ω, H/2 rate. Phasing Transition is coincident with leading edge of line sync. Polarity may be high or low during −135° burst lines.

**V/2 (1411R, 1412R Only)** — Level: 1 V, 75 Ω. Rate: 25 Hz (1411R) 30 Hz (1412R) squarewave. Phasing: Positive during Fields 2 and Field 4 (1411R). Field 1 and Field 3 (1412R).

**V/4 (1411R, 1412R Only)** — Level: 1 V, 75 Ω Rate: 12.5 Hz (1411R); 15 Hz (1412R) squarewave. Phasing: Positive during Field 1 and Field 4 (1411R); Field 1 and Field 2 (1412R).

**64H (1411R and 1412R Only)** — Level: 1 V, 75 Ω. Frequency: 1 MHz (1411R); 1.006993 MHz (1412R).

### SUBCARRIER OUTPUT

**Amplitude** — 2 V p-p into 75 Ω. Return Loss: ≥30 dB to 5 MHz.

### BLACK BURST OUTPUT

**Amplitudes** — Sync: 286 mV ±3.57 mV (1410R); −300 mV ±3 mV (1411R, 1412R) from blanking. Burst: 286 mV ±2.86 mV (1410R). Absolute: 300 mV ±9 mV. Relative: Alternate burst amplitudes equal within 1% (1411R, 1412R). Setup: 53.57 mV ±3.57 mV (1410R), 0% (1411R), 50 mV ±2.5 mV (1412R).

**VIR Signal (1410R Only)** — Chrominance: Amplitude 286 mV ±2.85 mV (40 IRE); phase within 0.5° of burst; envelope risetime $Sin^2$ shaped 1 μs ±150 ns. Luminance: Setup level 53.57 mV ±3.57 mV (7.5 IRE ±0.5 IRE); gray level 357 mV (50 IRE ±0.5 IRE); chroma pedestal 500 mV ±5 mV (70 IRE ±0.7 IRE); risetime and falltime $Sin^2$ shaped, 250 ns ±39 ns.

### GENLOCK

**Input Configuration** — 75 Ω Loop-Through With Return Loss: ≥−46 dB to 5 MHz (1410R); ≥40 dB to 7 MHz (1411R); ≥40 dB to 5 MHz (1412R).

**Input Requirements** — 1 V nominal composite video or black burst, sync negative. Sync Amplitude: Nominal ±6 dB. Burst Amplitude: Nominal ±12 dB. Burst Sync Ratio: Within 6 dB.

**Subcarrier Phase Range** — 360° via front-panel goniometer.

**Line Sync Delay Range** — Adjustable to advance output sync ≥10 μs or delay ≥4 μs (internal adjustment). A front panel screwdriver adjustment provides a delay/advance range of ±0.5 μs.

**Stability (Over Ambient Temperature Range 0°C to ±50°C)** — Line Lock: Within 70 ns. Subcarrier Lock: Within 35 ns.

**Field/Frame Sync** — Fast Lock: Direct-acting in one field. Slow Lock: One line/field slew.

**Loss of Lock** — Indicated by front-panel LED's (automatic switching to full or partial internal).

### EXTERNAL REFERENCE

**Input Configuration** — 75 Ω loop-through.

**Subcarrier Input Requirements** — Amplitude: 1.0 V to 4.0 V p-p. Frequency fsc: ±10 Hz. Return Loss: ≥46 dB to fsc.

**Comp Sync Input Requirements** — Amplitude: 2.0 V to 8.0 V p-p. Polarity: Negative.

**PAL Pulse Input** — Amplitude: 1.0 V to 8.0 V p-p, negative going. Waveshape: Pulse or squarewave. Timing: Pulse duration ≥4 μs. Squarewave Rate: H/2. Phasing: Pulse-negative going transitions coincident with start of line sync on either a +V or −V line (1411R, 1412R only).

**Loss of Lock** — Indicated by front-panel LED indicators. Automatic switching to partial or full internal reference.

**Subcarrier Stability** — Output follows input.

**Line Sync Delay Range** — Adjustable to advance output sync ≥10 μs or delay ≥4 μs (internal adjustment). A front panel screwdriver adjustment provides a delay/advance range of ±0.5 μs.

**Subcarrier Phase Range** — 360° via front-panel goniometer.

### COLOR BAR GENERATORS (TSG7, TSG11, TSG21)

**Luminance Signal Accuracy** — Within 1% or 1.5 mV, whichever is greater.

**Chrominance Accuracy** — Absolute Amplitudes: Within 3% (all subcarrier components). Relative Amplitudes: Within 1% of the red chrominance bars or 1 mV plus p-p residual subcarrier amplitude, whichever is greater.

**Full Field Displays** — Bar Width: 6.45 μs (TSG7); 6.5 μs (TSG11); 6.6 μs (TSG21). White Bar Risetime: 130 ns, +20 ns, −10 ns (TSG7); 115 ns ±15 ns (TSG11); 125 ns ±20 μs (TSG21). Time Difference Between Chroma and Lum Channels: ≤20 ns.

### CONVERGENCE TEST SIGNAL GENERATOR (TSG2, TSG12)

**Displays Available** — Crosshatch, vertical lines only, horizontal lines only, dots only, and crosshatch plus dots (dots appear centered in the rectangles formed by the crosshatch pattern). Horizontal and vertical positioning.

**Risetime and Falltime** — Pulses and setup 135 ns ±15 ns (TSG2); 115 ns ±15 ns (TSG12).

**Pulse Amplitude** — 77 IRE ±3 IRE (TSG2); 525 mV ±25 mV (TSG12).

### LINEARITY TEST SIGNAL GENERATOR (TSG3, TSG13, TSG23)

**Luminance Risetime** — 250 ns ±39 ns (TSG3); 250 ns ±50 ns (TSG13, TSG23).

**Five-Step Signal** — Step Amplitudes Nominal: 143 mV (TSG3); 140 mV (TSG13, TSG23). Relative: Largest within 1% of smallest.

**Ten-Step Signal** — Step Amplitudes Nominal: 71.5 mV (TSG3); 70 mV (TSG13, TSG23). Relative: Largest within 1% of smallest.

**Ramp Signal** — Linearity: ±1%.

**Linearity Subcarrier** — Absolute Amplitudes: ±3%. Relative Amplitudes: ±1%. 20 IRE: 143 mV (TSG3); 140 mV (TSG13, TSG23). 40 IRE: 285.7 mV (TSG3); 280 mV (TSG13, TSG23). Differential Gain: ≤0.5%. Phase: 180° ±1°. Differential Phase: 0.1°.

**Subcarrier Envelope** — Risetime: 400 ns ±60 ns (TSG3, TSG23); 350 ns ±50 ns (TSG13).

**Modulated Pedestal** — 90° Subcarrier. Amplitude: one level is 5 IRE to 20 IRE (TSG3); low level is internally adjustable (TSG13, TSG23). Three Levels: 20 IRE, 40 IRE and 80 IRE (TSG3); 140 mV, 420 mV and 700 mV (TSG13, TSG23).

**Bounce Modes** — Ac: Rate, 1/60 to ½ Hz. Dc: Rate, slow 1/60 to ½ Hz. Dc Rate. Fast Selectable: Line rate, field rate, or frame rate.

### PULSE AND BAR GENERATOR (TSG5, TSG15, TSG25)

| | Full Amplitude | Half Amplitude |
|---|---|---|
| **Luminance Bar Amplitude** Setup Off (TSG5) | 714.3 mV ±7.1 mV | 357.1 mV ±3.6 mV |
| (TSG15, TSG25) | 700.0 mV ±7.0 mV | 350.0 mV ±5.3 mV |
| **Modulated Bar Amplitude** Setup Off Luminance (TSG5) | 357.1 mV ±3.6 mV | 178.6 mV ±1.8 mV |
| (TSG15, TSG25) | 350.0 mV ±3.5 mV | 175.0 mV ±1.8 mV |
| P-P Chrominance (TSG5) | 714.3 mV ±14.3 mV | 357.1 mV ±7.1 mV |
| (TSG15, TSG25) | 700.0 mV ±14.0 mV | 350.0 mV ±7.0 mV |
| **Pulse Amplitude** Setup Off | | |
| 2T (TSG5) | 714.3 mV ±7.1 mV | 357.1 mV ±5.4 mV |
| −2T, T | 714.3 mV ±10.7 mV | 357.1 mV ±7.1 mV |
| T/2 | 714.3 mV ±14.3 mV | 347.1 mV ±14.3 mV |
| Modulated | 714.3 mV ±7.1 mV | 357.1 mV ±5.4 mV |
| 2T (TSG15, TSG25) | 700.0 mV ±7.0 mV | 350.0 mV ±5.3 mV |
| −2T, T | 700.0 mV ±10.5 mV | 350.0 mV ±7.0 mV |
| T/2 | 700.0 mV ±14.0 mV | 340.0 mV ±14.0 mV |
| Modulated | 700.0 mV ±7.0 mV | 350.0 mV ±5.3 mV |
| **Pulse to Bar Ratio** | | |
| 2T | 1:1 ±0.005 | 1:1 ±0.01 |
| −2T, T | 1:1 ±0.01 | 1:1 ±0.02 |
| T/2 | 1:1 ±0.02 | 1:1 ±0.04 |
| **Modulated Pulse to Modulated Bar** | 1:1 ±0.01 | 1:1 ±0.02 |

**Modulated Pulse and Bar** — Chrominance-Luminance Gain: 3.6 mV (3.5 mV for TSG15, TSG25) maximum amplitude difference of peak chrominance and peak luminance. Delay Residual: 5 ns maximum.

**Window** — Line Timing: Bar Timing.

Field Timing: White lines from line 67 to line 218 (line 65 to line 270 for TSG15, line 64 to line 215 for TSG25) each field. Field Tilt: 0.5% maximum.

**Field Squarewave** — Field Timing: White line 75 to line 206 (line 65 to line 221 for TSG15, line 64 to line 215 for TSG25). Field Tilt: 0.5% maximum.

**Pedestal** — Amplitude Luminance Off or Half Amplitude: 357.1 mV ±7.1 mV (TSG5) 350 mV ±7 mV (TSG15, TSG25).

### MULTIBURST SIGNAL GENERATOR (TSG6, TSG16, TSG26)

| | Low Range | High Range |
|---|---|---|
| **Multiburst Frequencies** (TSG6) | 500 kHz ±3%<br>1.25 MHz ±3%<br>2.00 MHz ±3%<br>3.00 MHz ±3%<br>3.58 MHz ±3%<br>4.10 MHz ±3% | 1.25 MHz ±3%<br>3.50 MHz ±3%<br>5.50 MHz ±3%<br>8.00 MHz ±3%<br>10.0 MHz ±3%<br>12.0 MHz ±3% |
| (TSG16) | 500 kHz ±3%<br>1.00 MHz ±3%<br>2.00 MHz ±3%<br>4.00 MHz ±3%<br>4.80 MHz ±3%<br>5.80 MHz ±3% | 1.00 MHz ±3%<br>3.00 MHz ±3%<br>5.00 MHz ±3%<br>8.00 MHz ±3%<br>10.0 MHz ±3%<br>12.0 MHz ±3% |
| (TSG26) | 500 kHz ±3%<br>1.00 MHz ±3%<br>2.00 MHz ±3%<br>3.00 MHz ±3%<br>3.58 MHz ±3%<br>4.20 MHz ±3% | 1.00 MHz ±3%<br>3.00 MHz ±3%<br>5.50 MHz ±3%<br>8.00 MHz ±3%<br>10.0 MHz ±3%<br>12.0 MHz ±3% |
| **Amplitude (First Multiburst Packet)** Full (TSG6) | 643 mV (90 IRE) ±20 mV | 643 mV ±25 mV |
| (TSG16, TSG26) | 700 mV ±21 mV | 700 mV ±28 mV |
| Reduced (TSG6) | 428 mV (60 IRE) ±12 mV | 428 mV ±16 mV |
| (TSG16, TSG26) | 420 mV ±12 mV | 420 mV ±16 mV |
| Flatness, Reduced and Full (TSG6) | 10 mV or less | 16 mV or less |
| (TSG16, TSG26) | 10 mV or less | 17.5 mV or less |
| Packet Envelope Risetime | 400 ns ±60 ns | 400 ns ±60 ns |
| Burst Phasing | Phase shifted at field rate to provide filled-in burst packets. | |
| **Sweep/Manual** Sinewave Frequencies Start<br>Stop<br>Amplitude at First Marker (TSG6) | 100 kHz minimum<br>6 MHz ±10%<br>643 mV ±20 mV | 330 kHz minimum<br>20 MHz ±10%<br>643 mV ±25 mV |
| (TSG16, TSG26) | 700 mV ±21 mV | 700 mV ±28 mV |
| Reduced (TSG6) | 428 mV ±12 mV | 428 mV ±16 mV |
| (TSG16, TSG26) | 420 mV ±12 mV | 420 mV ±16 mV |
| Flatness[3] Full and Reduced (TSG6) | 10 mV | 15 mV to 12 MHz<br>20 mV to 20 MHz |
| (TSG16, TSG26) | 10 mV | 17.5 mV to 12 MHz<br>21.0 mV to 20 MHz |
| **Markers** Frequencies | 500 kHz ±3%*1<br>1.0 MHz ±3%*1<br>2.0 MHz ±3%*1<br>3.0 MHz ±3%*1<br>4.0 MHz ±3%*1<br>5.0 MHz ±3%*1 | 1.0 MHz ±3%*1<br>2.0 MHz ±3%*1<br>4.0 MHz ±3%*1<br>6.0 MHz ±3%*1<br>8.0 MHz ±3%*1<br>10.0 MHz ±4%*1<br>12.0 MHz ±4%*2<br>14.0 MHz ±6%*2<br>16.0 MHz ±7%*2<br>18.0 MHz ±7%*2<br>20.0 MHz ±7%*2 |
| **Multiburst/Manual** (Last Burst Variable Mode) Frequency Range (TSG6, TSG26) | <3.8 MHz to >4.5 MHz | <14 MHz to 20 MHz ±10% |
| (TSG16) | <5.0 MHz to 6.0 MHz ±10% | <14 MHz to 20 MHz ±10% |
| Accuracy | ±0.2% short term | ±1% short term |

| | Low Range | High Range |
|---|---|---|
| **Amplitude** (Markers & Pedestal all Modes) Markers Relative to Pedestal Level Full (TSG6) (TSG16, TSG26) | ±321 mV ±1%<br>±350 mV ±1% | ±321 mV ±1%<br>±350 mV ±1% |
| Reduced (TSG6) (TSG16, TSG26) | ±214 mV ±1%<br>±210 mV ±1% | ±214 mV ±1%<br>±210 mV ±1% |
| Pedestal Level Full (TSG6) | 393 mV ±1% | 393 mV ±1% |
| (TSG16, TSG26) | 350 mV ±1% | 350 mV ±1% |
| Reduced (TSG6) | 286 mV ±1% | 286 mV ±1% |
| (TSG16, TSG26) | 350 mV ±1% | 350 mV ±1% |
| Risetime | 250 ns ±50 ns | 250 ns ±50 ns |
| **Harmonic Distortion** (Single Frequency Relative to Fundamental (TSG6, TSG26) | −44 dB, 0.3 to 4.2 MHz<br>−40 dB, 0.1 to 0.3 MHz<br>−40 dB, 4.2 to 6.0 MHz | −38 dB, 0.33 to 6.0 MHz<br>−36 dB, >6 to 20 MHz |
| (TSG16) | 43 dB, 300 kHz to 5.0 MHz<br>−40 dB, 100 kHz to 300 kHz<br>−40 dB, 5.0 MHz to 6.0 MHz | −38 dB, 330 kHz to 6.0 MHz<br>−36 dB, 6 MHz to 20 MHz |

*[1] Within one television line either side of the marker.*

*[2] Above 10 MHz, difference frequency between markers is 2 MHz ±400 kHz.*

*[3] Maximum-minimum diode detected peak-to-peak voltages.*

### SIGNAL SWITCHER (TSP1, TSP11, TSP21)

**Input Signal** — Amplifier Limits: 1.4 V p-p. Input Return Loss: ≥30 dB, to 5 MHz.

Input Isolation: ≥50 dB, internal inputs. Input Impedance: 75 Ω.

**Switcher Output Signal** — Timing: Same as inputs, delayed by ±10 ns (10° to 20° of subcarrier). Amplitudes: Within 2% of inputs. Blanking dc Level: 0 V ±100 mV.

Relative Blanking Level: Within 15 mV, between signals.

**Added Distortion** — Noise: <60 dB, to 5 MHz. Residual Subcarrier: <1 mV. Differential Gain: <0.5%. Differential Phase: <0.3°. Luminance Linearity: 1%. Pulse to Bar Ratio: 2T: 1:1 ±0.5%. Tilt: <1%, line or field. Flatness: 1% to 5 MHz, 2% to 10 MHz, 4% to 20 MHz.

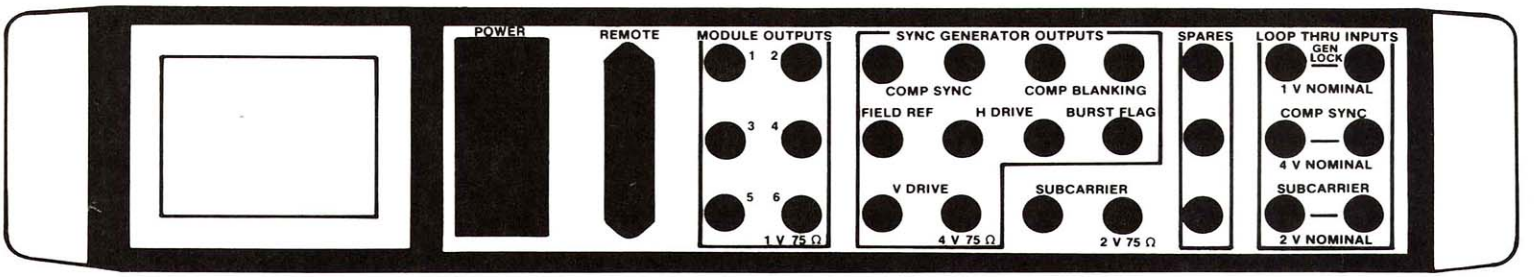
**Clamping** — Aberrations: <10 mV, at burst gate time. Output Return Loss: ≥30 dB to 5 MHz.

### CONVERGENCE

**Displays Available** — Crosshatch, vertical lines only, horizontal lines only, dots only, and crosshatch plus dots (dots appear centered in the rectangles formed by the crosshatch pattern). Horizontal and vertical positioning.

**Risetime and Falltime** — Pulses and setup 135 ns ±15 ns (TSP1), 115 ns ±15 ns (TSP11), 125 ns ±20 ns (TSP21).

**Pulse Amplitude** — 77.5 IRE ±3 IRE (TSP1), 525 mV ±25 mV (TSP11, TSP21).




*Rear panel of the 1410R*

### AC POWER

**Mains Voltage Ranges** — 90 V ac to 112 V ac. 106 V ac to 132 V ac, 180 V ac to 224 V ac and 212 V ac to 250 V ac. Factory set at 106 V ac to 132 V ac (1410R, 1412R), 212 V ac to 250 V ac (1411R).

**Power Consumption** — 130 W maximum.

**Mains Frequency** — 47 Hz to 63 Hz.

### ENVIRONMENTAL CHARACTERISTICS

**Temperature Range** — Operating: 0°C to +50°C. Nonoperating: −40°C to +65°C.

**Altitude Range** — Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 483 | 19.0 |
| Height | 88 | 3.5 |
| Depth | 488 | 19.2 |
| **Weight (w/Plug-ins)** | **kg** | **lb** |
| Net | 9.7 | 21.2 |
| Shipping | 21.4 | 47.1 |

### SAFETY CERTIFICATIONS

Underwriters Laboratories, Inc.: Listed, 242T; Canadian Standards Association: Certified, LR37158; International Electrotechnical Commission (IEC 348): Certified by Tektronix, Inc.

### INCLUDED ACCESSORIES

Extender board (670-4441-02); 1.5 A fuse (159-0016-00); 0.75 A fuse (159-0042-00); rackmount hardware; instruction manual.

## ORDERING INFORMATION

The 1410R (NTSC) and 1411R (PAL) Sync Pulse and Test Signal Generator Series card set construction allows ordering just the capabilities needed while leaving room for future expansion. For easy ordering of a 1410R or 1411R Generator, follow the steps listed here.

1. Select the functions needed. Choose up to a total of five test signal generators and signal switchers to be installed in the 1410R (NTSC) or 1411R (PAL) mainframe.
2. Check the 1410R or 1411R Standard Configuration charts to see if the combination selected is equivalent to a standard Option 03 or Option 04. If it is, order the Option 03 or Option 04. Do not combine any other options with Option 03 or Option 04. (Except that Option 10 for 1410R may be combined with Option 03 or Option 04). All 1410R and 1411R generators ordered in this manner are shipped with the test signal generators and signal switchers installed and fully calibrated in the mainframe.
3. If the desired combination is not one of the standard configurations, order a mainframe and order an alphanumeric option for each test signal generator or signal switcher in the desired combination. Each test signal generator or signal switcher ordered in this manner will be shipped installed and fully calibrated in the mainframe.
4. To add functions to an existing 1410R or 1411R generator order the desired test signal generator or signal switcher by its product name (e.g., TSG3). Each generator ordered in this manner will be shipped individually and installation into the mainframe is the responsibility of the customer.
5. When ordering more than one 1410R or 1411R Generator package on the same purchase order be sure to indicate the appropriate options to be included in each package.

### 1410R NTSC PACKAGES
### STANDARD CONFIGURATIONS

| | Option 03 | Option 04 |
|---|---|---|
| **TSG2** (Convergence) | x | |
| **TSG3** (Linearity) | x | x |
| **TSG5** (Pulse and Bar) | | x |
| **TSG6** (Multiburst) | | x |
| **TSG7** (Color Bars) | x | x |
| **TSP1** (Switcher) | | x |

**1410R** NTSC Mainframe and SPG2 ... **$4,200**

**Option 03*1** — NTSC Package Installed and Tested Together ..... **+$3,295**

**Option 04*1** — NTSC Package Installed and Tested Together ..... **+$7,885**

**Option 1B** — Adds TSG7 Installed ..... **+$1,780**

**Option 1S** — Adds TSP1 Installed ..... **+$1,565**

**Option 10** — ±10 Hz Color Subcarrier Frequency Accuracy ..... **−$405**

**Option 2C** — Adds TSG2 Installed ..... **+$505**

**Option 3L** — Adds TSG3 Installed ..... **+$1,250**

**Option 4M** — Adds TSG6 Installed ..... **+$2,265**

**Option 4P** — Adds TSG5 Installed ..... **+$1,625**

**1 Cannot be combined with any other option except may be combined with Option 10.*

**TSG2** Convergence Generator ..... **$530**
**TSG3** Linearity Generator ..... **$1,310**
**TSG5** Pulse and Bar Generator ..... **$1,715**
**TSG6** Multiburst Generator ..... **$2,375**
**TSG7** Color Bars Generator ..... **$1,870**
**TSP1** Switcher ..... **$1,640**

### 1411R PAL PACKAGES
### STANDARD CONFIGURATIONS

| | Option 03 | Option 04 |
|---|---|---|
| **TSG11** (Color Bars) | x | x |
| **TSG12** (Convergence) | x | |
| **TSG13** (Linearity) | x | x |
| **TSG15** (Pulse and Bars) | | x |
| **TSG16** (Multiburst) | | x |
| **TSP11** (Switcher) | | x |

**1411R** PAL Mainframe and SPG12 .... **$4,200**

**Option 03*1** — PAL Package Installed and Tested Together ..... **+$3,000**

**Option 04*1** — PAL Package Installed and Tested Together ..... **+$7,500**

**Option 1B** — Adds TSG11 Installed ..... **+$1,500**

**Option 1S** — Adds TSP11 Installed ..... **+$1,535**

**Option 2C** — Adds TSG12 Installed ..... **+$495**

**Option 3L** — Adds TSG13 Installed ..... **+$1,225**

**Option 4M** — Adds TSG16 Installed ..... **+$2,220**

**Option 4P** — Adds TSG15 Installed ..... **+$1,595**

**1 Cannot be combined with any other option.*

**TSG11** Color Bars Generator ..... **$1,575**
**TSG12** Convergence Generator ..... **$520**
**TSG13** Linearity Generator ..... **$1,285**
**TSG15** Pulse and Bar Generator ..... **$1,680**
**TSG16** Multiburst Generator ..... **$2,330**
**TSP11** Switcher ..... **$1,610**

### 1412R PAL-M PACKAGES

**1412R** PAL-M Mainframe and SPG22, TSG21 ..... **$7,415**

**Option 05** — Adds TSG23/TSG25/TSG26/TSP21 Installed ..... **+$8,795**

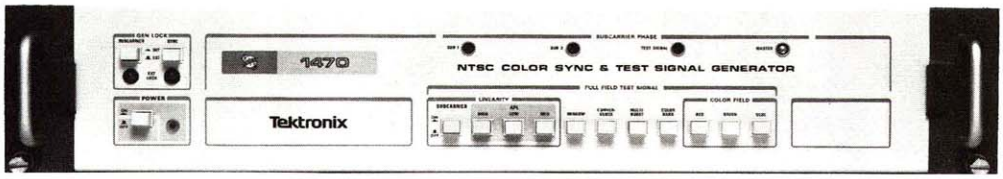
### OPTIONAL ITEMS (FOR ALL CONFIGURATIONS)

**Single-Width Blank Panel** — Order 333-2171-00 ..... **$1.35**

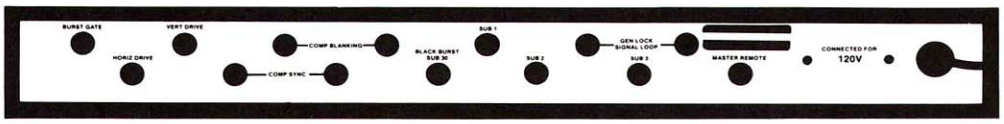
**Conversion Kit for SMPTE Bars** — For TSG1 Module. Order 040-1010-00 ..... **$375**

**Rackmount to Cabinet Conversion Kit** — Order 040-1152-00 ..... **$90**

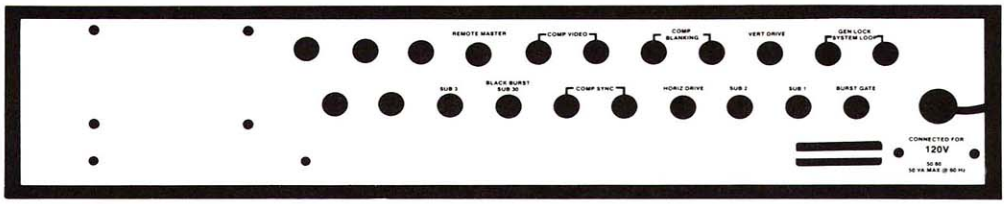
*1474 NTSC Color Sync Generator*




*1470 NTSC Color Sync and Test Signal Generator*




*1474 Rear Panel*




*1470 Rear Panel*

## 1470/1474

**Full Color Sync Generator with Gen-Lock**

**Locks to Most Helical Scan VTRs**

**Simple to Operate**

**Compact and Economical**

**Full Selection of Sync and Timing Signals**

**Simplified Timing Via Multiple Subcarrier Phasing Controls**

The 1470 Sync and Test Signal Generator is a compact, full color, gen-lock sync generator providing a full selection of high quality test signals.

The 1474 is identical in performance to the 1470 with the exception of test signals which, in the interest of economy, are not included. Both products have color gen-lock compatible with composite video from all normal sources including most helical scan video tape recorders.

The 1470 and 1474 can operate as master-sync generators or as units fully or partially timed from external sources. Color gen-lock capable of locking to most helical scan VTRs is a standard feature.

Front-panel pushbutton selection of external synchronization is provided. In external mode, the 1470 and 1474 automatically lock on composite video (1 V), composite sync (−4 V), or reference subcarrier (2 V). Two front-panel lights show subcarrier and/or sync external lock. Lights out indicate a switch to internal standard.

### 1470 Test Signal Functions

To simplify your test signal selection and speed testing operations, the 1470 has push button selection of test signals. All test signal push buttons, except the color field selectors, are self-cancelling. Each test signal provides aberration-free transitions and accurate flat levels.

### Color Bars

The 1470 provides full-field color bars signals useful for color monitor adjustments, VTR tape lead in, and system checks.

### Color Fields

Red, green, and blue color-field signals are provided for checking purity on color monitors/receivers that do not have individual gun on/off controls. These signals may also be used to provide a color background source. The red, green, and blue selectors may be used simultaneously to provide yellow, cyan, magenta, and white full field signals.

### Linearity (Staircase)

Staircase signal with selection of high, medium, or low APL. Staircase subcarrier may be switched on or off from the front panel.

### Test Signals

Test Signals available include: Window, Convergence Multiburst.

Window signals are suitable for measuring both line time and field time distortion. Convergence test signals are used to check color monitor convergence and linearity, and camera scanning linearity. Multiburst signals are used to check system frequency response.

Both the 1470 and 1474 are configured for rackmounting and are shipped ready to install in a 19 inch rack.

## CHARACTERISTICS

### SYNC GENERATORS OUTPUTS (1470/1474)

**Horizontal Blanking** — Leading Edge: 2.2 μs to 0.6 μs before the leading edge of sync. Trailing Edge: 9.1 μs to 10.7 μs after the leading edge of sync.
**Horizontal Drive** — Leading Edge: 2.2 μs to 0.6 μs before the leading edge of sync.
**Vertical Blanking** — 20 lines or 21 lines.
**Subcarrier Phase Controls** — Composite Test Signals: Subcarrier 1 and 2. Blackburst: Independent adjustment range of ≈120°, and jumpers allow a full 360° shift in 90° steps. Gen-Lock Master: Independent 360° front panel adjustment and 100° remote control, via a rear-panel BNC connector.

### GEN-LOCK

**Composite Sync** — Output Level Into 75 Ω: 4 V ±0.5 V. Risetime and Falltime: 140 ns nominal.
**Composite Blanking** — Output Level Into 75 Ω: 4 V ±0.5 V. Field Blanking Risetime and Falltime: 140 ns nominal.
**Vertical Drive** — Output Level Into 75 Ω: 4 V ±0.5 V. Risetime and Falltime: 140 ns nominal. Duration: 9 lines.
**Horizontal Drive** — Output Level Into 75 Ω: 4 V ±0.5 V. Risetime and Falltime: 140 ns nominal. Duration: 6.35 μs.
**Burst Gate** — Output Level Into 75 Ω: 4 V ±0.5 V. Delay from Line Sync: 5.1 μs ±0.1 μs. Risetime and Falltime: 140 ns nominal. Duration: 2.5 μs ±100 ns.
**Subcarrier** — Output Level Into 75 Ω: 2 V. Frequency: 3.579545 MHz ±10 Hz.
**Black Burst** — Sync Amplitude Into 75 Ω: 40 IRE. Burst Amplitude: 40 IRE (286 mV p-p). Burst Frequency: 3.579545 MHz ±10 Hz.
**Gen-Lock Signal Loop Input** — Composite Video Input Range: 0.5 V to 1 V when loop-through connectors are externally terminated into 75 Ω. Comp Sync: 1 V to 4 V, ref subcarrier 1.5 V p-p to 2 V p-p.

### TEST SIGNAL OUTPUTS (1470)

**Test Signal Generator Outputs Composite Video** — Return Loss: ⩾30 dB to 5 MHz. Output Level Into 75 Ω: 1 V. Sync: 40 IRE, ±1 IRE (286 mV nominal amplitude). Peak Video Level: 100 IRE, ±2 IRE (714 mV nominal amplitude). Blanking Dc Level: 0 V, ±50 mV.
**NTSC Color Bars** — Full Field: 75% amplitude, 100 IRE white reference, 7.5% setup. Luminance Signal Accuracy: Within 2%. Chrominance Signal Absolute Amplitudes: Within 3% (all subcarrier frequency components).
**Window Amplitude** — 100 IRE, ±2 IRE. Duration: 25.8 μs, ±3%. Starts at line 66 in each field and ends at 218 in each field. Risetime: 150 ns nominal.
**Crosshatch Pattern or Dots** — Setup: 7.5 IRE ±1 IRE. Peak Level: 77 IRE ±2 IRE. Risetime and Falltime: 150 ns nominal.
**Multiburst** — White Reference Amplitude: 100 IRE ±2 IRE. Multiburst Amplitude: 50 IRE ±2 IRE. Average Level: 55 IRE ±1 IRE. Multiburst Frequencies: 0.5 MHz, 1.5 MHz, 2.0 MHz, 3.0 MHz, 3.58 MHz, 4.2 MHz.
**Staircase Luminance Component** — Five Step Amplitude (each step): 20 IRE ±1 IRE (143 mV). Staircase Amplitude: 100 IRE ±2 IRE (714 mV). Aberrations: Within 2% of step amplitude. Step Risetime: 150 ns nominal.
**Staircase Subcarrier Chrominance Component** — Amplitude: 40 IRE ±1 IRE (286 mV p-p). Phase: 180°. Differential Phase: ⩽0.3°. Differential Gain: ⩽0.5%. Subcarrier Envelope Risetime: 400 ns nominal.

### OTHER CHARACTERISTICS

**1470 Power Requirements** — 115 V or 240 V line voltage, high-low ranges. Selection switches for line voltages and ranges are accessible internally. Factory set to 120 V. 120 V Range: High, 108 V to 132 V; Low, 95 V to 110 V. 240 Range: High, 216 V to 250 V; Low, 198 V to 242 V. Line Frequency: 50 Hz to 60 Hz. Power Maximum: 50 W. 1474 Power Requirements: 115 V: 90 V to 130 V. 240 V: 198 V to 250 V. Power: Maximum 40 W.

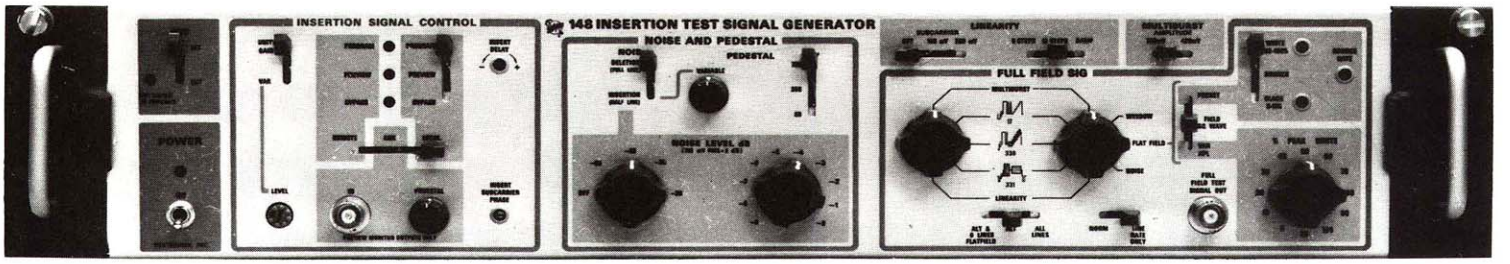
### PHYSICAL CHARACTERISTICS

| Dimensions | 1470 | | 1474 | |
|---|---|---|---|---|
| | mm | in | mm | in |
| Width | 483 | 19.0 | 483 | 19.0 |
| Height | 89 | 3.5 | 44 | 1.7 |
| Depth | 483 | 19.0 | 483 | 19.0 |
| **Weights** | **kg** | **lb** | **kg** | **lb** |
| Net | 4.9 | 10.8 | 4.2 | 9.2 |
| Shipping | 7.8 | 17.2 | 8.1 | 17.9 |

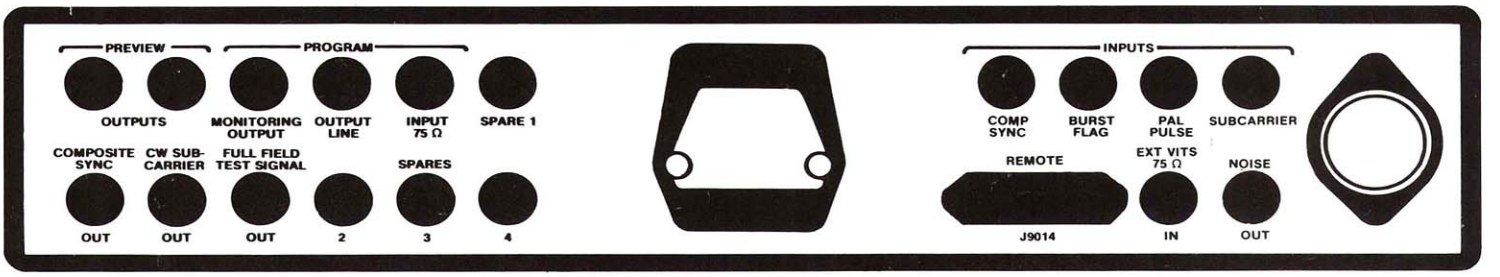
## ORDERING INFORMATION

**1470** Color Sync and Test Signal Generator (Rackmount) ..... **$3,595**

**1474** Color Sync Generator (Rackmount) ..... **$2,095**




*R148 PAL Test Signal Generator*




*R148 Rear Panel*

## R148/R148-M

**Insertion Test Signals (Per EBU, CCIR Recommendation 473-2, Annex 1)**

**Full-Field Test Signals (Per CCIR Recommendation 567)**

**Easily Reprogrammable**

**Safe In-Service ITS Insertion (Per EBU Specifications)**

**Noise Measurement**

**APL Bounce Signal**

**Source Identification Code**

**Operates with Sound In Syncs**

**Locks with Mixed Sync (Per EBU Homologation Specifications for ITS Generators) Subcarrier, PAL Pulse, Burst Flag, Comp Sync**

The Tektronix R148 (PAL) and R148-M (PAL-M) Insertion Test Signal (ITS) Generators provide all the test signals you need to test and measure PAL (or PAL-M) video transmission systems. Test signals are available as both full-field composite video and ITS inserted into the incoming program signal's vertical blanking interval. All timing information for ITS insertion is derived from the incoming composite video signal.

### VERTICAL INTERVAL INSERTION/ DELETION AND PROGRAM CONTROL

The R148 and R148-M insert ITS only when genlocked to an incoming composite video signal. Since ITS insertion/deletion involves active circuit elements in the program line, program line fail safe operation is provided in the event of instrument malfunction, loss of sync, or power failure. You also have access to local and remote control manual override capability.

A preview monitor output permits observation of the ITS deletion/insertion program before anything is actually done to the program signal. Preview/program operation can be locally or remotely controlled.

Provisions are made for adding an externally generated ITS to the program line.

### INSERTION SIGNAL CONTROL FEATURES

#### Free Running Operation

A warning light indicates absence of incoming synchronizing information and ITS deletion and insertion is automatically discontinued.

#### Program Level

A front panel switch lets you select a preset gain, normally adjusted for unity gain between program input and program output. Or, you can use a front panel level adjustment to normalize the incoming program signal to provide 1 volt at the program output.

#### Local-Remote Control of Program and Preview

You can shift control of program or preview modes from the front panel (local) to a position remote from the generator. When operating under either local or remote control, front panel lights indicate program line status, since the front panel program status switch position may not correspond to the operating mode selected.

#### Program-Preview-Bypass

This three-position switch is used to select one of three modes: Program, Preview, or Bypass.

Program: In this switch position, ITS is inserted on program line output according to internal selection of test signals and their time addresses.

Preview: In this switch position, ITS is inserted only on program, as viewed on the preview monitor output. Preview is used for verification prior to inserting these signals on program output.

Bypass: In this switch position, incoming program material bypasses R148 functions and output is unchanged.

#### Auxiliary

A noncomposite video signal (such as a sweep generator) applied to the auxiliary input appears at the preview monitor output connector with composite blanking and sync added. A pedestal control provides a dc offset so the auxiliary signal excursion may be positioned between the black and white limits of the resulting composite video signal. Remote control is not available.

#### ITS Subcarrier Phase

A recessed front-panel control adjusts phase of color subcarrier on internally generated signals to be correct in relation to the phase of incoming burst.

#### Insertion Delay

A recessed front-panel control provides a fine horizontal timing adjustment for inserted signals.

### TEST SIGNALS

The R148 provides the following PAL Insertion Test Signals which meet CCIR recommendation 569, 473-2, Annex 1. (These signals are also available full field):

Line 17
Line 330
Line 331

The R148 also provides these PAL Full Field Test Signals:

Field Squarewave
Flat Field
Linearity
Multiburst
Noise Measurement
Window

The R148-M provides these PAL-M Insertion Test Signals which are also available full field:

CCIR-I (Recommendation 473-2, Annex I )
CCIR-II (Recommendation 473-2, Annex II)
SIG-III (CCIR recommendation 567, Figure 27)

The R148-M also provides these PAL-M Full Field Test Signals:

Field Rate Sweep
Field Squarewave
Flat Field
Linearity
Modulated Pulse and Bar
Window

### FULL-FIELD OPERATION

The Tektronix R148 and R148-M provide full-field test signals separate from program. These signals are generated with or without external synchronizing information and will be locked to the external synchronizing signal when a program signal or external synchronizing signals are present.

### FLAT-FIELD SIGNAL

The flat-field signal with VITS inserted is used primarily for system testing at discrete average picture levels.

The flat-field signal is a composite video signal that, during the active portion of each field, has a constant luminance level. The luminance level is selectable in eleven increments from 0% to 100% of white. An alternate selection provides automatic change between black and white with a period variable form 1 s to 10 s.

When operating the R148 in the flat field mode, you may select a white level preset between 85% and 100% and a black level preset between 0% and 15%. Automatic change between white and black is available and occurs at a period adjustable from 1.0 s to 10.0 s.

### FIELD SQUAREWAVE SIGNAL

The field squarewave signal is used to measure field time distortions. In this mode, the Tektronix R148 provides a composite video signal with 205 active lines at 700 mV, approximating a 50 Hz squarewave. The R148-M provides a composite video signal with 132 active lines at 700 mV, approximating a 60 Hz squarewave.

Use this signal to detect low frequency phase and gain distortions, even those passing through clamper amplifiers.

### LINEARITY SIGNAL

You can select three Linearity Test Signals: 5 step, 10 step, or ramp (either modulated or unmodulated). The subcarrier component is phase-locked to color burst. Use this signal for measuring differential gain and phase, dynamic gain, luminance signal linearity, luminance signal distortion caused by chrominance signal nonlinearity, and burst phase and amplitude errors.

### WINDOW SIGNAL

The window signal in the R148 consists of a modulated 20T pulse followed by a 2T pulse followed by a bar with 2T risetime. The bar portion of the signal occupies the center 205 lines of each field. The window signal in the R148-M consists of a 2T pulse followed by a bar with a 2T risetime. The bar portion of the signal occupies the center 152 lines of each field.

### MULTIBURST SIGNAL (R148 ONLY)

The multiburst signal is generated by a function generator controlled by a digital programmer. This design eliminates the need for individual start/stop oscillators on each burst and individual amplitude and ac axis adjustments. Each burst start time is completely stable, and each burst packet consists of an exact number of cycles, regardless of the frequency. Each burst starts at 0° of the first cycle and ends at 360° of the last cycle. Location of the white flag with relation to the bursts is programmable and may be used for source identification.

### NOISE SIGNAL (R148 ONLY)

When the noise signal is selected the active picture lines contain noise generated by an internal calibrated noise source.

### FIELD RATE SWEEP (R148-M ONLY)

This signal consists of a sinewave that is swept in frequency from about 200 kHz to more than 6 MHz during each field period. Markers are spaced at about 1 MHz intervals. Composite sync and blanking are added to make the signal compatible with clamp circuits.

### MOD PULSE AND BAR (R148-M ONLY)

This signal consists of a 12.5T modulated pulse and a modulated bar with 12.5T risetimes and falltimes.

## CHARACTERISTICS

#### PROGRAM CHANNEL

**Input Level** — Adjusted to unity gain.

**Variable Input Level** — ±30%.

**Inserted Signal Level** — Within ±1% of nominal.

**Output Dc Level** — <50 mV (no signal).

**Frequency Response, Program, and Preview Channels** — ±1%, 50 kHz to 5 MHz.

**Field Time Tilt** — <0.5%.

**Line Time Tilt** — <0.25%.

**Differential Phase Standard Input** — Program Output: <0.15°. Preview Output: <0.3°.

**Differential Gain Standard Input** — Program Output: <0.2%. Preview Output: <0.4%.

**Random Noise Output Program Channel** — <−75 dB RMS.

**Hum, Transients on Noninserted Lines** — ⩾60 dB down.

**Spurious Signals During Blanking Time** — Inactive line time ⩾40 dB down. Active ITS lines ⩾60 dB.

**Signal Attenuation in "Delete" Mode** — 2T Pulse: >−70 dB. Subcarrier (Color Bars): >−60 dB.

**Crosstalk into Program Channel from Internal Signals** — 2T Pulse: <−70 dB. Subcarrier (Color Bars): <−60 dB.

**Unwanted Pedestal at Time of ITS Insertion** — Program and Preview Channel: <5 mV.

**Insert Delay Adjustment Range** — ±0.5 μs front panel.

#### SOURCE IDENTIFICATION CODE (R148 ONLY)

The Tektronix R148 is a source identification code generator with up to 25 pulses available in any combination on line 16 or line 329.

**Pulse Width** — 1 μs.

**One Level** — 630 to 700 mV above blanking.

**Zero Level** — Within 25 mV of blanking.

#### OTHER CHARACTERISTICS

**Power Requirements** — 90 V ac to 136 V ac or 180 V ac to 272 V ac; 48 Hz to 66 Hz, 55 W maximum at 115 V ac and 60 Hz. Factory set at 230 V ac (R148) or 115 V ac (R148-M).

**Ambient Temperature** — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 483 | 19.0 |
| Height | 88 | 3.5 |
| Depth | 499 | 19.7 |
| **Weights** | **kg** | **lb** |
| Net | 9.1 | 20.0 |
| Shipping≈ | 16.3 | 36.0 |

#### INCLUDED ACCESSORIES

75 Ω BNC termination (011-0103-02); two each BNC-T adaptors (103-0030-00); rackmounting hardware (351-0195-01); manual.

## ORDERING INFORMATION

**R148 PAL** Test Signal Generator ..... **$5,540**
**R148M PAL-M** Test Signal Generator . **$8,700**

#### OPTIONAL ACCESSORIES

**Noise Measurement Filters** — External filters are required with the 148 Generator when making noise measurements.

**Low Pass 6.0 MHz 625/50** — Order 015-0220-00 ..... **$100**

**Noise Weighting 5.0 MHz 625/50** — Order 015-0215-00 . **$80**

**Low Pass 4.2 MHz 525/60** — Order 015-0212-00 ..... **$125**

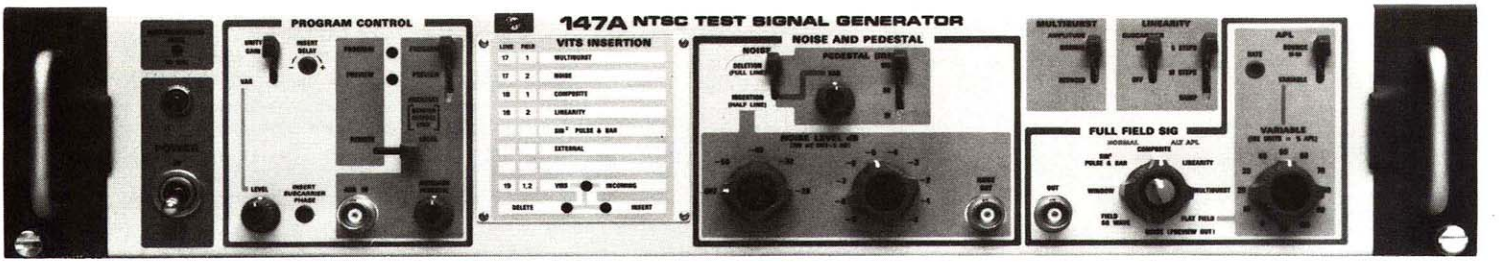
**Noise Weighting 4.2 MHz 525/60** — Order 015-0214-00 . **$90**

CCIR recommendation 568 provides for measuring signal-to-weighted random noise on all international transmissions (both 525/60 and 625/50) with a 5.0 MHz low pass filter and a unified noise weighting filter.

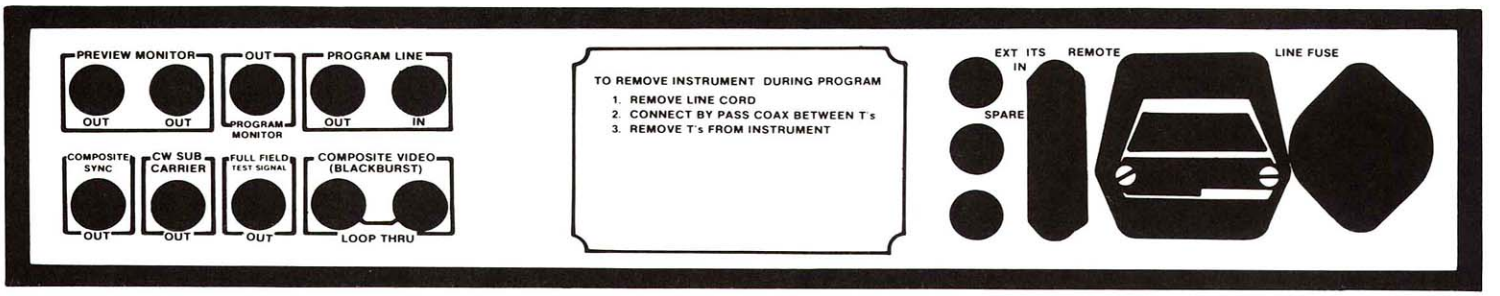
**Low Pass 5.0 MHz** — Order 015-0213-00 ..... **$125**

**Unified Noise Weighting Network** — Order 015-0283-00 ..... **$65**

**Rackmount to Cabinet Conversion Kit** — Order 040-0573-00 ..... **$150**




*R147A NTSC Test Signal Generator*




*R147A Rear Panel*

## R147A

**VITS Generation, Insertion, and Deletion**

**Sync and Burst Regeneration**

**Program Signal Protected**

**Full Field Test Signals Independently Selectable from VITS Program**

**Reprogrammable for New Signals**

**Vertical Interval Reference Signal**

**Noise Test Signal and Measurements**

The R147A NTSC Television Signal Generator provides the test signals commonly used for test and measurement of video transmission systems. The signals generated are available as full-field composite video test signals and Vertical Interval Test Signals (VITS) that may be inserted on an incoming composite video signal.

### VERTICAL INTERVAL INSERTION/ DELETION AND PROGRAM CONTROL

The R147A will insert VITS only when gen-locked to an incoming composite video signal. A VITS deleter/inserter involves active circuit elements in the program line within the generator. Fail-safe provisions are provided in the event of a malfunction within the instrument, including loss of sync or power. Local and remote-control manual override capability is also provided.

When an incoming program is lost, the R147A will go to one of two operating modes selectable by internal reprogramming jumpers. They are: program line bypass, or full-field test signal or flat-field signal. In the event the program signal is lost, the transmitter will continue on the air.

### PROGRAM CONTROL FEATURES

**Processing Amplifier**

In addition to performing deletion and insertion functions, the R147A generator is designed to function as a sync and burst regeneration amplifier.

### TEST SIGNALS

The R147A provides the following NTSC Vertical Interval Test signals. These signals are also available full field (except VIRS):

Composite
Linearity
Multiburst
Noise
Pulse and Bar
VIRS

The R147A also provides these full field test signals:

Field Squarewave
Flat Field
Window

### NOISE TEST SIGNAL

The R147A offers a signal-to-noise measuring technique for in-service testing during the vertical interval. The noise present in the middle portion of a line is deleted while the noise generated in a calibrated source is inserted for measurements by comparison. You then adjust the calibrated attenuator until inserted and incoming noise appears the same on a waveform monitor. The measured noise values are independent of operator interpretation errors to within 2 IRE.

### CHARACTERISTICS

#### PROGRAM CONTROL SYSTEM

**Input Level** — Adjusted to unity gain.

**Variable Input level** — ±30%.

**Input Return Loss** — >46 dB to 5 MHz. Power on, 40 dB to 5 MHz in bypass.

**Inserted Signal Level** — 714 mV (100 IRE) ±1%.

**Frequency Reponse, Program, and Preview Channel** — ±1%, 50 kHz to 5 MHz; +1%, −5%, 5 MHz to 8 MHz.

**2T Pulse to Bar Ratio** — 100% ±0.5%.

#### OTHER CHARACTERISTICS

**Power Requirements** — 90 V ac to 136 V ac or 180 V ac to 272 V ac, 48 Hz to 66 Hz, 40 W maximum at 115 V ac and 60 Hz.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 483 | 19.0 |
| Height | 89 | 3.5 |
| Depth | 436 | 17.9 |
| **Weights** | **kg** | **lb** |
| Net | 9.1 | 20.0 |
| Shipping | 16.3 | 36.0 |
| Export Shipping | 25.4 | 56.0 |

#### INCLUDED ACCESSORIES

75 Ω, BNC termination (011-0103-02); two each BNC-T adaptors (103-0030-00); front panel protective cover (200-1246-00); rackmount slide (351-0195-01); manual.

### ORDERING INFORMATION

**R147A** NTSC Signal Generator ..... **$9,750**

#### OPTIONAL ACCESSORIES

**Noise Measurement Filters** — External filters are required with the 147A Generator when making noise measurements.

**Low Pass 4.2 MHz 525/60** — Order 015-0212-00 ..... **$125**

**Noise Weighting 4.2 MHz 525/60** — Order 015-0214-00 ..... **$90**

CCIR recommendation 568 provides for measuring signal-to-weighted random noise on all international transmissions (both 525/60 and 625/50) with a 5.0 MHz low pass filter and a unified noise weighting filter.

**Low Pass 5 MHz** — Order 015-0213-00 ..... **$125**

**Unified Noise Weighting** Order 015-0283-00 ..... **$65**

**Rackmount to Cabinet Conversion Kit** — Order 040-0573-00 ..... **$150**

*1430 Random Noise Measurement Set Front Panel*

## 1430

**Conforms to CCIR Recommendation 568**

**In-Service Testing**

**Out-of-Service Testing**

**Program Material Protected by Fail-Safe Provisions**

**525/60 or 625/50 Standards**

The 1430 provides random noise measurement capabilities on an in-service basis using the spatially adjacent noise matching technique with a waveform monitor. A program channel allows deletion of VITS and/or noise on selected lines in the vertical blanking interval and a monitor channel is provided for making measurements in conjunction with a waveform monitor.

The 1430 has two sections. One section, permanently mounted in the rack, contains inputs and outputs and program protecting material. The second section, containing circuitry and controls, may be easily removed without cable disconnection.

### Monitor Channel

The monitor channel has an output independent from program for waveform comparison of the noise on the incoming signal and noise from the internal noise generator. Front-panel controls determine monitor channel parameters with three operating modes: VITS, Full Field, and Out of Service.

In the VITS mode, any line between 10 and 21 in either or both fields may be selected for insertion of the reference noise. The Full Field mode provides insertion on all active lines.

The Out of Service mode is provided for measurements on sources that do not have composite sync. In particular, these include transmission circuits not carrying signals at the time testing is conducted. Horizontal sync is added for waveform monitor synchronization.

In all modes the insertion width is internally set at 26 μs. Delay between insertion and sync is controlled by the Delay adjustment. A switch and a potentiometer covering a range of 0 IRE to 100 IRE controls the insertion pedestal level.

Monitor channel gain control, with a ±3 dB range, allows nomalizing the signal for a 1 V peak-to-peak signal so that noise measurement relative to 1 V may be made. The internal noise weighting filter may be switched in or out from the front panel for evaluation of the spectral content of the incoming noise. This filter is the monitor channel only and does not affect the program output.

The 1430 may be used on both 625/50 and 525/60 systems but is shipped equipped for 525/60. The 1430 Option 01 is equipped for 625/50. Both models use the unified weighting filter per CCIR Recommendation 568. Insertion loss characteristics are as follows:

| Insertion Loss ≈ | |
|---|---|
| 1 MHz | 5.9 dB |
| 2 MHz | 10.2 dB |
| 3 MHz | 12.0 dB |
| 4 MHz | 13.0 dB |
| 5 MHz | 13.6 dB |

### Program Channel

The Program Channel has a 75 Ω input impedance and unity gain and output impedance of 75 Ω. No program impairment is introduced. A relay provides program signal continuity if the 1430 loses power. Internal programming, readily changeable, controls all deletion parameters. Up to three lines between 10 and 21 in either or both fields may be deleted. The deletion may be varied between the first half, second half, or full active portion of the video line. A pedestal may be inserted in the deleted portion of a line at 10 IRE, 50 IRE, or 100 IRE levels.

## CHARACTERISTICS

#### PROGRAM CHANNEL

**Signal Input Level** — 1 V nominal.

**Input Impedance** — 75 Ω nominal.

**Input Return Loss** — Power On: ≥46 dB to 5 MHz. Power Off or Bypass: ≥40 dB to 5 MHz.

**Output Impedance (Operating)** — 75 Ω nominal.

**Output Return Loss (All)** — ≥30 dB to 5 MHz.

**Output Blanking, Dc Level** — 0 V within 50 mV, for blanking pulses.

**Inserted Pedestal Level** — Adjustable to 100 IRE, 50 IRE, 10 IRE, or 0 IRE.

**2T Pulse to Bar Amplitude** — Within 0.25%.

**Mod Sin² Pulse (Chrominance and Luminance)** — 100% within 0.5%.

**Waveform, Tilt** — Field Rate Squarewave ≤0.5%, 26 μs Bar, ≤0.5%.

**Differential Phase (10% to 90% APL, Standard Input)** — Program Output: ≤0.15°.

**Differential Gain (10% to 90% APL, Standard Input)** — Program Output: ≤0.2%.

**Line Time Amplitude Nonlinearity (10% to 90% APL, Standard Input)** — ≤0.5%.

**Random Noise** — Program Output: ≥75 dB (RMS) down (using weighting and low pass filters, 5 MHz).

**Hum or Transients on Noninserted Lines** — ≥60 dB down, (using weighted and low pass filters, 5 MHz).

**Spurious Signals During Blanking Lines** — ≥40 dB down, low pass (5 MHz).

**Signal Attenuation in Delete Mode** — 2T Pulse: ≥70 dB down. Subcarrier (Color Bars): ≥60 dB down. Insertion pedestal: 10 IRE, 50 IRE, and 100 IRE, first half, second half, or entire line (up to 3; 10 to 21) or full field.

**Unwanted Pedestal at Time of VITS Insertion** — ≤0.7 IRE.

**Time Jitter** — ≤5 ns.

#### NOISE

**Pedestal Level** — Pedestal Amplitude: 10 IRE, 50 IRE, and 100 IRE.

**Pedestal Position (Insertion Mode Only)** — Delay: 10 μs to 50 μs.

**Noise Amplitude** — 20 dB to −59.5 dB (0 dB = 700 mV RMS).

**Noise Attenuators** — Absolute Amplitude: Within 1 dB.

**Noise Spectrum** — Energy/Unit Bandwidth: Flat within 6 dB, 15 kHz to 5 MHz.

**Output Impedance** — 75 Ω nominal.

**Output Return Loss** — ≥30 dB.

**Noise Weighting and Low Pass Filter** — Per CCIR recommendation 421-2.

#### AC POWER

**Line Voltage Range** — 115 V ac: 90 V to 132 V. 230 V ac: 180 V to 264 V. Standard 1430: Factory set at 115 V ac. 1430 Option 01: Factory set at 230 V ac.

**Maximum Line Current** — 0.25 A.

**Maximum Power Consumption** — 30 W.

**Line Frequency Range** — 48 Hz to 66 Hz.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 483 | 19.0 |
| Height | 44 | 1.7 |
| Depth | 429 | 16.9 |
| **Weights** | **kg** | **lb** |
| Net | 4.5 | 10.0 |
| Shipping | 7.2 | 16.0 |

#### INCLUDED ACCESSORIES

One pair slide guide (351-0331-03); cover program front panel (200-1481-00); manual.

## ORDERING INFORMATION

**1430** Random Noise Measuring Set (525/60) ..... **$4,115**

**Option 01** — Random Noise Measuring Set (625/50) .. **+$85**

The 1430 and 1430 Option 01 are provided with the 5.0 MHz low pass filter and unified weighting filter per CCIR Recommendation 568.

*1440 NTSC Automatic Video Corrector*

*Remote Control Unit*

*Remote Monitor Unit*

## 1440

**Reduces Operating Costs**

**Extends Transmitter Tube Life and Reduces Maintenance Costs**

**Maintains Consistent High Quality Color Pictures**

**Automates Transmitter Modulation Level Control**

**Maintains Correct Sync-To-Video Ratios During Line Voltage Fluctuations**

**Automatic VIRS Referenced Correction of:**
- **Overall Video Signal Amplitude**
- **Chrominance to Luminance Gain Ratio**
- **Black Level**
- **Chrominance Phase**
- **Burst Gain**
- **Sync Gain**

**Optional Closed Loop Capabilities for Greater Efficiency and Economy in Transmitter and VTR Operations**

The 1440 VIRS Automatic Video Corrector gives fully automatic correction of video gain, chrominance to luminance gain ratio, black level (set up), chroma phase, burst amplitude, and sync amplitude errors. With this corrector in your facility, the quality of the program signal is rigidly maintained. Ordinary changes and even many severe distortions are automatically corrected.

Video gain correction is referenced to the 50 IRE level of the VIRS. Chrominance to luminance gain ratio and burst phase corrections are referenced to the amplitude and phase of the VIRS chrominance respectively. Set up level correction is referenced to the 7.5 IRE level of the VIRS. Sync and burst gain corrections are controlled respective to their standard amplitudes.

### Auxiliary Units

In most applications, the usefulness of automatic correction is enhanced by a Tektronix Remote Control Unit. You can conveniently select corrector modes and manually correct six signal parameters with this unit. The remote unit allows easy adjustment of the parameter's preset values for operation in the absence of a reference signal. Automatic correction value adjustments are also provided.

The Tektronix Remote Monitoring Unit provides meter indications of the amount of correction applied to the signal.

### CHARACTERISTICS

**Input Impedance** — 75 Ω nominal.

**Video Delay** — 145 ns.

**Output Impedance** — 75 Ω.

**Linear Waveform Distortions (Maximum)** — Field Time: 0.5%, Line Time: 0.5%. Short Time: T Pulse/Bar: 2%. 2T Pulse/Bar: 1%.

**Nonlinear Waveform Distortions** — Differential Gain (10% to 90% APL): 0.5%. Differential Phase (10% to 90% APL): 0.5%. Dynamic Gain (10% to 90% APL): Picture 0.5%, sync 0.5%. Chrominance/Luminance Intermodulation: 0.5%. Line Time Nonlinearity: 0.5%.

**Unweighted Video Signal to Random Noise Ratio** — ≥60 dB to 5 MHz.

**Spurious Subcarrier** — −60 dB.

**Field Time Tilt Correction** — 25% Tilt on Input Signal: Will be reduced to ≤1%.

**Clamping Characteristics** — 10% to 90% APL or 90% to 10% APL. Recovery within one line to within five IRE without overshoot. Slow clamp option provided to reduce keyboarding when used with noisy signals. Hum Reduction: 1 V hum on input signal can be reduced to ≤25 mV.

**Maximum Correction Ranges** — Video Level at Input: ±6 dB. Sync Level at Input: ±3 dB. Chrominance/Luminance Gain: ±3 dB. Burst Level: ±6 dB Burst/Chrominance Phase: ±25°. Black Level Set Up: ±10 IRE.

**Reduced Correction Ranges** — Video Level: ±2 dB. Sync Level: ±3 dB. Chrominance/Luminance Gain: ±3 dB. Burst/Chrominance Phase: ±25°. Black Level Set Up: ±5 IRE.

**Dc Error-Signal Output** — Source Impedance: 10 kΩ. Open Circuit Voltage: 10 V for remote metering and telemetry. Six Outputs: Video gain, sync gain, burst gain, relative chroma gain, burst phase, and set up.

**Chroma/Luminance Gain Correction (+3 dB to −3 dB) −2T Pulse/Bar Ratio** — 110% maximum and 92% minimum. T Pulse/Bar Ratio: 125% maximum and 85% minimum. 2T Pulse Preshoot: 5% maximum. T Step Overshoot: 5% maximum. T Step Risetime: 95 ns minimum and 155 ns maximum. Chrominance/Luminance Delay: 10 ns minimum and 10 ns maximum. VIR Signal Correction Rate: 0.35 s (90% correction without overshoot).

#### POWER SUPPLY

**Line Voltage Range** — 115 V ac ±10% and 230 V ac ±10%.

**Maximum Power Consumption** — 35 W.

**Line Frequency Range** — 48 Hz to 66 Hz.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 483 | 19.0 |
| Height | 881 | 3.5 |
| Depth | 412 | 16.2 |
| **Weight** | **kg** | **lb** |
| Net | 7.6 | 16.7 |
| Domestic Shipping | 11.0 | 24.1 |
| Export Shipping | 16.8 | 37.0 |

### ORDERING INFORMATION

**1440** NTSC Automatic Video Corrector **$6,325**

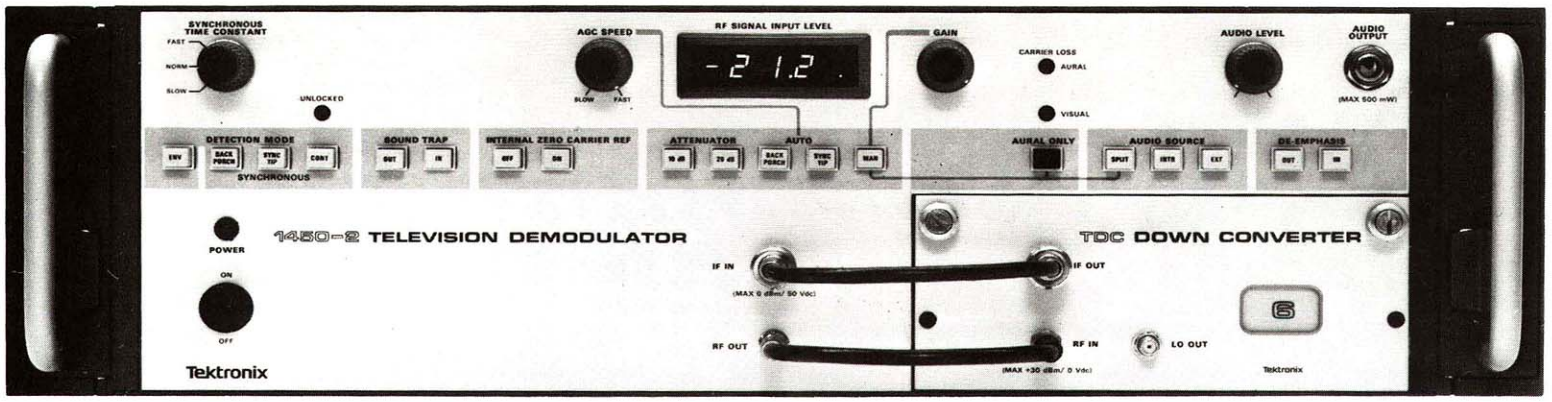
#### OPTIONAL ACCESSORIES

**Remote Control Unit for 1440** — (Includes two connectors). Order 015-0240-00 ..... **$775**

**Remote Monitor Unit for 1440** — (Includes one connector). Order 015-0239-00 ..... **$900**

**Six Foot Extender Cable** — With connectors for use between the 1440 and Remote Control Unit or Remote Monitor Unit. Order 012-0131-00 ..... **$325**

**Three Foot Extender Cable** — With connectors, for use between the 1440 chassis and the rear rackmounting section. Order 012-0637-00 ..... **$330**




*The 1450-1 is compatible with System M Television Transmission, the 1450-2 is compatible with System B/G, and the 1450-3 is compatible with System I.*

## 1450-1/1450-2/1450-3

**Measurement-Quality Performance for Negligible Distortion**

**Synchronous Detection Elminates Quadature Distortion**

**Envelope Detection for Accurately Determined Differential Phase**

**Surface Acoustic Wave Filter Provides Precise Nyquist Slope; Excellent Long and Short-Term Stability**

**Digital Readout of Input Power Level for Easy, Accurate Field Strength Readings**

**Constant-Bandpass Characteristics Over Wide Dynamic Range**

**Any Single VHF or UHF Channel Operation**

**UHF and VHF Tunable Down Converters**

**Conforms to EIA Standard RS-462 (System M Only)**

The 1450-1 (System M), 1450-2 (System B/G) and 1450-3 (System I) Demodulator Mainframes are combined with a Tektronix Television Down Converter (TDC) to provide an accurate link between your transmitter's RF signals and video baseband measuring equipment. Unique components work together to identify and eliminate any possible demodulation distortion in reproduced signal characteristics. You see a transparent picture of your transmitter's performance and signal output.

High Performance Spectrum Analyzers for your RF measurements are described on pages 202-216.

**Tunable or Fixed-Channel Down Converters**
For demodulating an RF signal at a TV channel frequency, the 1450 Series demodulator mainframes must be used with a Tektronix TDC. Three compatible TDCs are available for each system and provide a selection between tunable and fixed-channel performance. The TDC Fixed-Channel Down Converter supports your specified system channel number. Tunable Down Converters available for VHF and UHF channels are the TDC1 and TDC2 respectively.

Demodulation of the transmitter IF signal may be accomplished by using only the mainframe.

**Synchronous and Envelope Detection**
The 1450 Series demodulators allow you to select either synchronous or envelope detection. Each method has advantages, yet both are required for full measurement capability. For instance, synchronous detection is necessary for measurements that can be seriously affected by quadrature distortion.

The 1450 Series demodulators have two synchronous video detectors operating in phase quadrature. One detects the in-phase signal; the other detects the quadrature component of the video signal. (The quadrature component is a measure of change in visual carrier phase resulting from a change of video level.)

However, if incidental phase modulation is present on the picture carrier, the amount of differential phase measured on a synchronously detected signal will be erroneous. Because of this, an envelope detector is necessary to determine the actual differential phase present. The envelope detector has linear transfer characteristics down to 3% carrier and so provides optimum modulation depth indication.

**Tektronix-Developed Surface Acoustic Wave Filter**
The 1450 Series demodulators feature a SAW (surface acoustic wave) filter developed by Tektronix. It provides more precise Nyquist slope characteristics without group delay distortion, improves long-term and short-term stability, and lowers maintenance costs compared to conventional filter network circuitry.

In conventional demodulators, the more precisely the bandpass characteristics approach an ideal Nyquist curve, the more complex the filter network required. In the 1450 Series demodulator mainframes however, the bandpass characteristics are determined by just a single component, the SAW filter. Precision is the result.

Conventional tuned IF circuitry must be meticulously adjusted and is subject to change with mechanical and thermal shock. But the SAW filter is in a sealed unit and accurately provides the critical selectivity characteristics of the demodulator —and requires no adjustments.

**Constant-Bandpass Characteristics**
The Tektronix 1450 Series demodulators offer constant-bandpass characteristics over the entire dynamic range of input signal level. Amplifiers in the mainframe operate at a constant gain, and pin-diode attenuators are used to adjust the overall gain of the demodulator. This more sophisticated approach to AGC (automatic gain control) is necessary to maintain constant-bandpass characteristics over the entire dynamic range of input power (−69 dBm to −3 dBm). Additional attenuation of 30 dB, available in 10 dB steps, can shift the range for higher input power levels. In addition to AGC, demodulator RF/IF gain control can be set for manual operation.

**Digital Reading of Input Power**
With the accurate (to 0.1 dB) digital readout you get measurements of input power you can depend on at transmitter sites, remote sites, or, for calibrated field strength measurements.

**Split and Intercarrier Sound**
For making measurements or adjustments on aural transmitters, the 1450 Series demodulators feature both split and intercarrier sound channels. The split carrier channel, which will operate without the presence of the visual carrier, may be used when making measurements on the aural transmitter only.

Four audio outputs give added measurement capability: a 600 Ω output, two low impedance outputs for driving a speaker or headphones, and a calibrated output for making deviation measurements with an ac voltmeter or an oscilloscope.

**Quadrature Distortion**
Quadrature distortion occurs when a single sideband signal is demodulated with an envelope detector.

Quadrature distortion most severely affects the chrominance signal, causing a loss of brightness in highly saturated colors, especially those at high luminance levels. Narrow white picture elements against the dark backgrounds are reproduced at reduced brightness.

Synchronous detection of the television RF signal elminates quadrature distortion, allowing the true performance of the transmitter to be determined.

## CHARACTERISTICS

| RF Characteristics | Fixed Channel TDC | Tunable TDC1 or TDC2 |
|---|---|---|
| RF Input Impedance | 50 Ω (N)*1 | 50 Ω (N)*1 |
| Return Loss with 0 dB attenuation | ⩾20 dB | ⩾10 dB |
| Return Loss with ⩾20 dB attenuation | ⩾30 dB | ⩾30 dB |
| Frequency | Any System B, G, I or M assigned carrier frequency ±20 kHz | (TDC1) All System B or M VHF assigned carrier frequencies, ±27 kHz<br>(TDC2) All System G, I, or M UHF assigned carrier frequencies, ±27 kHz |
| Level Range | | |
| (0 dB from mainframe attenuator) | −69 dBm to −3 dBm | −65 dBm to +1 dBm |
| (10 dB from mainframe attenuator) | −59 dBm to +7 dBm | −55 dBm to +11 dBm |
| (20 dB from mainframe attenuator) | −49 dBm to +17 dBm | −45 dBm to +21 dBm |
| (30 dB from mainframe attenuator) | −39 dBm to +27 dBm | −35 dBm to +31 dBm |
| AGC Range | 66 dB | 66 dB |
| Noise Figure VHF | ⩽10 dB | TDC1 ⩽19 dB |
| UHF | ⩽11 dB | TDC2 ⩽19 dB |
| Adjacent Channel Cross Modulation | ⩾60 dB | ⩾60 dB |
| Alternate Channel Cross Modulation | ⩾60 dB | ⩾60 dB |
| Variation in Frequency Response with AGC | (VHF) ⩽±0.1 dB<br>(UHF) ⩽±0.15 dB | System B, G, I ⩽±0.4 dB<br>System M ⩽±0.3 dB |

**1 In 50 Ω:* *+27 dBm = 5 V RMS* *+31 dBm = 8 V RMS*
*−3 dBm = 158 mV RMS* *+1 dBm = 251 mV RMS*
*−69 dBm = 80 μV RMS* *−65 dBm = 126 μV RMS*

### IF

**Input Impedance ($Z_{in}$)** — 50 Ω (BNC).

**Return Loss** — >18 dB.

**IF Level Range** — −20 dBm to −64 dBm. (Signal to noise ratio deteriorates as signal level decreases.)

**IF Frequency**

1450-1: Visual is 37 MHz, 38.9 MHz, or 45.75 MHz ±127 kHz (as specified by the mainframe/TDC options). Aural is 4.5 MHz below visual.

1450-2: Visual is 38.9 MHz ±127 kHz. Aural is 5.5 MHz below visual.

1450-3: Visual is 38.9 MHz ±127 kHz. Aural is 6.0 MHz below visual.

### VIDEO

**Video Output** — $Z_O$: 75 Ω (2 BNC). Return Loss: ⩾34 dB. Level 1 V p-p sync tip to peak white.

**Dc Level** — Back Porch AGC: Blanking level at 0 V ±50 mV. Sync Tip AGC: Referenced to blanking level, sync tip is at −286 mV ±5.7 mV (1450-1), −300 mV ± 6 mV (1450-2, 1450-3).

**Line Time Distortion** — ⩽0.5%, wideband IF, synchronous detection. 1.0% in all other IF, detection mode combinations.

**Field Time Distortion** — ⩽0.5%.

**Line Time Nonlinearity** — ⩽1%.

**Differential Gain** — Synchronous: ⩽1%. Envelope: ⩽4%.
**Differential Phase** — ⩽1°.

**Chrominance/Luminance Delay** — ⩽±20 ns.

**Chrominance/Aural/Visual Carrier Intermod** — ⩾50 dB down.

**Aural Signal Rejection** — ⩾46 dB.

**Video Signal to Noise Ratio** — Low Frequency (p-p video/p-p hum): ⩾60 dB. Mid Frequency Coherent (p-p video/p-p noise): ⩾50 dB. White Noise (p-p video/RMS noise): ⩾60 dB.

**Quadrature Output** — $Z_O$: 75 Ω (BNC). Return Loss: ⩾34 dB. Quadrature Phase: 90° ±2° (with respect to Video Out).

**Zero Carrier Reference Gate**

1450-1: Width is 30 μs ±10%. Delay is 20 μs ±10% from leading edge of sync. Carrier Cutoff is ⩾50 dB. Zero Carrier is ±0.5 IRE. Timing Factory is set to line 20 of both fields, internally selectable from line 10 through line 25 of both fields.

1450-2, 1450-3: Width is 30 μs ±10%. Carrier Cutoff is ⩾50 dB. Zero Carrier is ±3.5 mV. Timing Factory Set to Line is 16/329 of both fields, internally selectable from line 10/323 through line 25/338 of both fields.

**EXT Zero Carrier Reference Drive Input** — $Z_{in}$: ≈5 kΩ (BNC). Level Required: ≈±1 V.

### AUDIO

**Frequency Response**

1450-1: De-emphasis Out is ±0.4 dB (30 Hz to 20 kHz). De-emphasis In Standard is 75 μs. De-emphasis Curve is ±0.4 dB.

1450-2, 1450-3: De-emphasis Out is ±0.4 dB (30 Hz to 25 kHz). De-emphasis In Standard is 50 μs. De-emphasis Curve is ±0.5 dB.

**Harmonic Distortion** — ⩽0.2% (30 Hz to 15 kHz at full output with ±25 kHz deviation) for 1450-1 or ±50 kHz deviation for 1450-2 and 1450-3.

**Audio Signal to Noise Ratio** — Intercarrier Mode: ⩾55 dB. Split Carrier Mode: 1450-1, 1450-2 is ⩾75 dB. 1450-3 is ⩾70 dB. External Aural Intercarrier In: ⩾75 dB. Aural Only Mode: ⩾75 dB. All at 1 kHz modulation and ±25 kHz (±50 kHz for 1450-2 and 1450-3) deviation.

**Deviation Output** — $Z_O$: 600 Ω (BNC). Level: 50 mV/kHz ±1% (20 kHz/V ±1%).

**Aural Intercarrier In** — $Z_{in}$: 50 Ω (BNC). Return Loss: ⩾20 dB. Level: −30 dBm ±5 dB.

**Aural Intercarrier Output** — $Z_O$: 50 Ω (BNC). Return Loss: ⩾20 dB. Level Nominal: −6 dBm up to 0 dBm.

**600 Ω Balance Line Output** — Level +10 dBm except 1450-3 level +8 dBm (internally adjustable from ⩽−10 dBm to +15 dBm). Connector XLR.

**8 Ω Speaker Output** — Level up to 5 W RMS, front panel adjustable. Connector Barrier block.

**Headphone Output** — Level up to 50 mW into 8 Ω headphone (stereo or mono style). Connector phone jack.

**Remote Connector** — Alarm output SPDT relay contact rated at 28 V, 3 A. External synchronous/envelope switch. Ground for envelope detection.

**Electromagnetic Susceptibility** — Up to 10 V/meter.

**Damage Level at RF Input** — 1 W maximum (any attenuator setting).

### AC POWER

**Line Voltage Ranges** — 100 V ac ±10%, 120 V ac ±10%, 220 V ac ±10%, 216 V ac to 250 V ac.

**Power Consumption** — 100 W maximum.

**Mains Frequency** — 48 Hz to 62 Hz.

### ENVIRONMENTAL CHARACTERISTICS

**Temperature Range** — Operating: 0°C to +50°C.

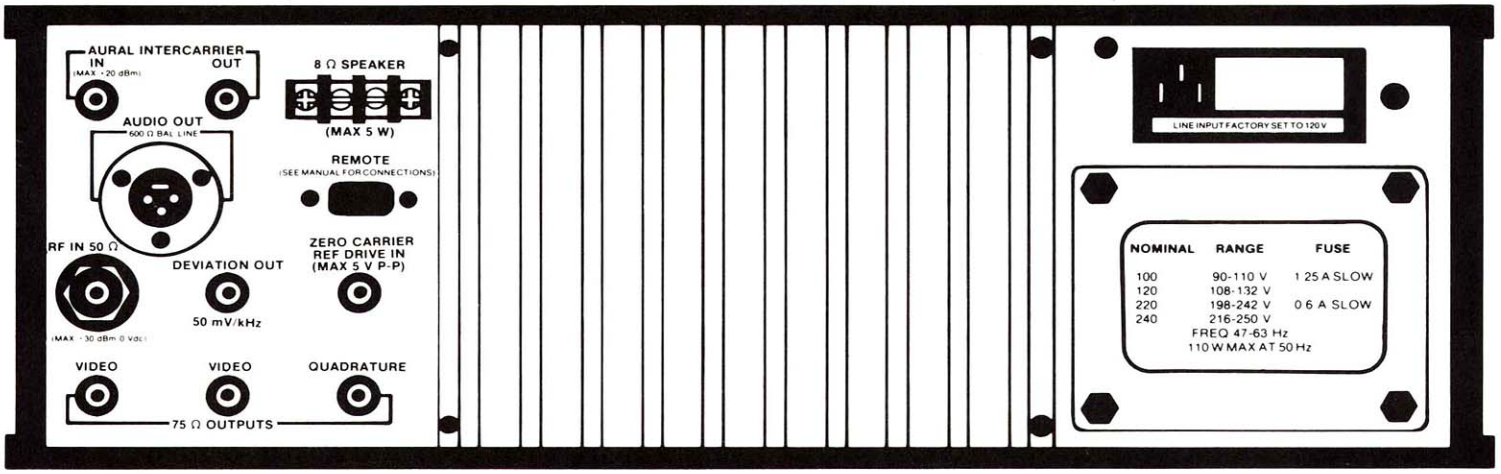
**Altitude Range** — Operating: Sea level to 4570 m (15,000 ft).

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 483 | 19.0 |
| Height | 133 | 5.3 |
| Depth | 486 | 19.1 |
| **Weight** | **kg** | **lb** |
| Mainframe | 16.3 | 36.0 |
| Down Convertor | 2.3 | 5.0 |

### INCLUDED ACCESSORIES

Pair rackmount slide guide (351-0301-03); N to BNC coaxial adaptor (103-0045-00); extender circuit board (670-5034-00); 50 Ω BNC coax cable (012-0751-00); 50 Ω SMA double shield coax cable (012-0752-00); two BNC to square-pin-adaptor cables (175-2140-00); BNC to Peltola adaptor cable (067-0709-00); TORX screwdriver (003-0816-00); male connector (131-1007-00); hood (200-1170-00); two screws (213-0260-00); low pass filter (015-0352-00). For 1450-1: ICPM graticule (331-0393-12); 0.6 A slow blow fuse (159-0043-00). For 1450-2 and 1450-3: ICPM graticule (331-0393-15); 1.25 A slow blow fuse (159-0041-00); manual.




## ORDERING INFORMATION, SYSTEM M

**1450-1** Television Demodulator (Order one vision IF option) ..... **$14,400**

**Option 01** — 37 MHz Vision IF ..... **NC**

**Option 02** — 38.9 MHz Vision IF ..... **NC**

**Option 03** — 45.75 MHz Vision IF ..... **NC**

**Option 10** — Wide Bandwidth Audio 20 Hz to 55 kHz ±0.4 dB ..... **+$170**

**For demodulation of RF signals, one of the following three down converters must be plugged into the 1450-1 mainframe.**

Order one vision IF option and either Option 11 or 14.

**TDC Fixed Channel Down Converter** — (Stiplulate channel number when ordering.) ..... **$3,550**

**TDC-1** — Tunable Down Converter VHF Band ..... **$7,660**

**TDC-2** — Tunable Down Converter UHF Band ..... **$7,660**

**Option 01** — 37 MHz Vision IF ..... **NC**

**Option 02** — 38.9 MHz Vision IF ..... **NC**

**Option 03** — 45.75 MHz Vision IF ..... **NC**

**Option 11** — System M Countries ..... **NC**

**Option 14** — System M Countries ..... **NC**

## ORDERING INFORMATION, SYSTEM B/G

**1450-2** Television Demodulator (Order both Option 02 and Option 09) ..... **$11,900**

**Option 02** — 38.9 MHz Vision IF ..... **NC**

**Option 09** — +90 ns/−170 ns Group Delay ..... **NC**

**Option 10** — Wide Bandwidth Audio 20 Hz to 55 kHz ±0.4 dB ..... **+$165**

**For demodulation of RF signals, one of the following three down converters must be plugged into the 1450-2 mainframe. Order both Option 02 and Option 12.**

**TDC Fixed Channel Down Converter** — (Stiplulate channel number when ordering.) ..... **$3,550**

**TDC-1** — Tunable Down Converter VHF Band ..... **$7,660**

**TDC-2** — Tunable Down Converter UHF Band ..... **$7,660**

**Option 02** — 38.9 MHz Vision IF ..... **NC**

**Option 12** — System B/G/I countries ..... **NC**

## ORDERING INFORMATION, SYSTEM I

**1450-3** Television Demodulator (Order Option 02) ..... **$13,145**

**Option 02** — 38.9 MHz Vision IF ..... **NC**

**Option 10** — Wide Bandwidth Audio 20 Hz to 55 kHz ±0.4 dB ..... **+$165**

**For demodulation of RF signals, one of the following three down converters must be plugged into the 1450-3 mainframe. Order both Option 02 and Option 12.**

**TDC Fixed Channel Down Converter** — (Stiplulate channel number when ordering.) ..... **$3,550**

**TDC-1** — Tunable Down Converter VHF Band ..... **$7,660**

**TDC-2** — Tunable Down Converter UHF Band ..... **$7,660**

**Option 02** — 38.9 MHz Vision IF ..... **NC**

**Option 12** — System B/G/I countries ..... **NC**

**COUNTRIES: SYSTEM M (Option 11)**

Antigua, Barbados, Bermuda, Brazil, Canada, Chile, Colombia, Costa Rica, Cuba, Curacao, Dominican Republic, Ecuador, El Salvador, Guam, Guatemala, Johnston Islands, Korea, Mexico, Micronesia, Netherlands Antilles, Nicaragua, Panama, Peru, Phillipines, Puerto Rico, Samoa, St. Kitts, Surinam, Taiwan, Trinidad/Tobago, Uruguay, U.S.A., Venezuela, Virgin Islands.

**COUNTRIES: SYSTEM M (Option 14)**

Japan and Okinawa.

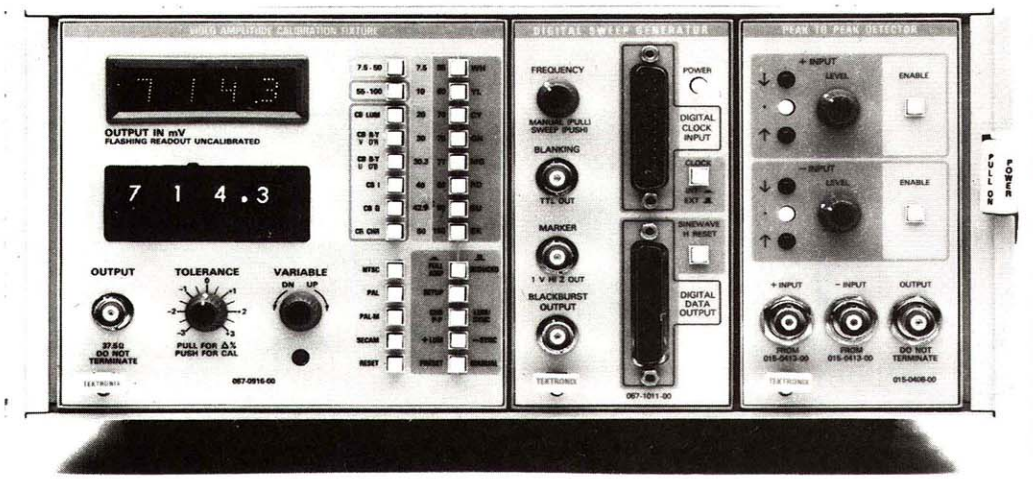
**COUNTRIES: SYSTEM B/G/I (Option 12)**

Algeria, Austria, Bahrain, Bangladesh, Belgium*2, Brunei, Cyprus, Denmark, East Germany, Egypt, Equatorial Guinea, Ethiopia, Finland, Ghana, Gibraltar, Greece, Hong Kong, Iceland, India, Indonesia, Iran, Iraq, Israel, Ireland (UHF)*1, Italy (UHF), Jordan, Kenya, Kuwait, Lebanon, Liberia, Libya, Malta, Mauritius, Netherlands, Nigeria, Norway, Oman, Pakistan, Portugal, Qatar, Rhodesia, Saudia Arabia*2, Sierra Leone, Singapore, South Africa (UHF)*1, Spain, Sudan, Sweden, Switzerland, Syria, Tanzania, Thailand*2, Tunisia, Turkey, Uganda, United Arab Emirates, United Kingdom (UHF)*1, West Germany, Yemen Arab Republic, Republic of Yemen, Yugoslavia, Zambia.

*1 *System I*

*2 *System B only.*

# TEK DIGITAL SWEEP GENERATOR, PEAK-TO-PEAK DETECTOR AND VIDEO AMPLITUDE CALIBRATION FIXTURE




*Video Amplitude Calibration Fixture, Digital Sweep Generator, and P-P Detector shown in a Tektronix TM 504 Mainframe*

Accurate calibration and verification of video equipment performance is essential for maintenance of optimum television system quality and thus signal quality.

New products, as well as calibration standards and procedures, have been developed to help provide accurate and NBS-traceable calibration and performance verification of Tektronix television products.

## VIDEO AMPLITUDE CALIBRATION FIXTURE

**Provides a Standard Reference for Amplitude Calibration**

**Preset Values for Common Video Signals**

**NTSC, PAL, PAL-M, SECAM Compatible**

The VAC (Video Amplitude Calibration Fixture) is a precision test fixture used in the measurement of common video signals and the calibration of video test signal generators and waveform monitors. It provides a simple means of measuring and calibrating luminance and chrominance amplitudes associated with most video signals.

The VAC provides a squarewave amplitude reference from 0.0 mV to 999.9 mV peak with a resolution of 0.1 mV and an accuracy of 0.05%. Signal amplitude may be selected using a four-digit front panel lever-switch or from over 500 preset values stored in EPROM. The VAC preset amplitudes are compatible with NTSC, PAL, PAL-M and SECAM television systems.

In the design of the VAC, careful attention was paid to thermal tilt to ensure accurate conversion from dc calibration to squarewave output. Unique choice of output impedance compensates loading effects when calibrating equipment with loop-through inputs.

The calibration of the VAC requires only a digital voltmeter with an accuracy of 0.01%.

The VAC operates in any of two compartments of the Tektronix TM 500 or TM 5000 Series power modules (except TM 501).

### CHARACTERISTICS

**Output Signal**
**Front Output Connector** — 37.5 Ω; BNC connector located on front panel.
**Rear Interconnect** — 0.0 Ω; Rear edge connector pins 27A and 28A.
**Amplitude Range (Tolerance Disabled)** — 0 mV to 999.9 mV ±(0.05% +0.1 mV); p-p squarewave amplitude.
**Amplitude Range (Tolerance Enabled)** — 0 mV to 999.9 mV ±(0.5% +0.1 mV) + Tolerance reading; p-p squarewave amplitude.
**Resolution** — 0.1 mV.
**Risetime** — >1 μs.
**Frequency** — NTSC, PAL-M, 270 Hz nominal; PAL, SECAM, 275 Hz nominal.

**ENVIRONMENTAL**
**Normal Operating Temperature** — +15°C to +35°C.
**Operating Temperature Range** — 0°C to +50°C.
**Weights** — Net: 1.4 kg, (3.0 lb). Net Shipping: 4.5 kg, (10.0 lb).

**INCLUDED ACCESSORIES**
(±0.025%) 75 Ω Terminator (011-0102-01); 0.06% attenuator (011-0134-00); subcarrier harmonic rejection filter (015-0407-00); manual.

### ORDERING INFORMATION

**Video Amplitude Calibration Fixture** Order 067-0916-00 ..... **$2,250**

**OPTIONAL ACCESSORIES**
**Low Loss Cable 72 inch 75 Ω** — Order 012-0159-01 .... **$35**

## PEAK-TO-PEAK DETECTOR

**NBS-Traceable Frequency Response Standard**

**Ultra Flat Response**

**Detector Amplifier Corrects Detector Diode Gain and Offset Errors**

The 015-0408-00 Detector Amplifier, combined with a 015-0413-00 Detector Head, comprise an NBS-traceable peak-to-peak detector system for baseband video frequency response testing. This system allows precise comparison of sinewave amplitudes at frequencies throughout the video spectrum. Typical response is accurate to as low as ±0.02% (±0.002 dB).

The frequency response of an analog generator may be calibrated using the peak-to-peak detector system as a transfer standard. The generator may then be used as a frequency response transfer standard to calibrate frequency response and chrominance-luminance gain of test equipment such as waveform monitors and vectorscopes.

A second detector head may be ordered for differential measurements.

### CHARACTERISTICS

**Input Signal Range** — 0.25 V to 1.0 V p-p.
**Envelope Gain Unit** — ±0.1% for 1% signal change.
**Input Impedance** — 75 Ω.
**Frequency Response**

| Frequency | Performance Requirements | Supplemental Information | | |
|---|---|---|---|---|
| | | Typical Response | Transfer Uncertainties | |
| | | | TEK | NBS |
| 25 kHz | +0.1, −0.7% | +0, −0.25% | ±0.05% | ±0.01% |
| 50 kHz | +0.1, −0.3% | +0, −0.1% | ±0.05% | ±0.02% |
| 100 kHz | ±0.1% | ±0.05% | ±0.05% | ±0.02% |
| 200 kHz | ±0.1% | ±0.02% | ±0.05% | ±0.05% |
| 500 kHz | ±0.1% | ±0.02% | ±0.05% | ±0.05% |
| 1 MHz | 0.0% (Reference) | ±0.02% | ±0.05% | ±0.05% |
| 2 MHz | ±0.1% | ±0.02% | ±0.05% | ±0.1% |
| 5 MHz | ±0.1% | ±0.02% | ±0.05% | ±0.1% |
| 10 MHz | ±0.15% | ±0.05% | ±0.05% | ±0.1% |
| 20 MHz | ±0.2% | ±0.1% | ±0.05% | ±0.2% |
| 30 MHz | ±0.5% | ±0.2% | ±0.1% | ±0.2% |
| 50 MHz | ±2.0% | ±1.0% | ±0.2% | ±0.5% |

**INCLUDED ACCESSORIES**
Detector head and data sheet with NBS-traceability curves (015-0413-00); 72 in low loss 75 Ω cable (012-0159-01); manual.

### ORDERING INFORMATION

**Peak-to-Peak Detector** Order 015-0408-00 **$1,265**

**OPTIONAL ACCESSORIES**
**Extra Detector Head** — (For differential measurements). Order 015-0413-00 ..... **$195**

## DIGITAL SWEEP GENERATOR

### Digitally Derived Sweep Signal

### 10-Bit Digital Data for Use with 1900-Series Digital Test Signal Generators to Reconstruct Analog Sweep

### Frequency Range 55.9 kHz to 7.16 MHz Field Sweep or (Manually Adjustable) CW

The Digital Sweep Generator provides 10-bit, 14.31818 MHz, digital data words derived from a cosine lookup table. The output signal sweeps from 55.9 kHz to 7.16 MHz in each field with high spectral purity and amplitude accuracy when used with the DAC in a 1900 Series generator. A front panel connector provides SMPTE*[1] compatible balanced ecl data. Data is continuous through blanking so that it can be used with noncomposite video detectors. Sync and burst may be inserted by a 1900 Series generator using the blanking output on the DSG if desired. The Digital Sweep Generator may be locked to a 1900 Series generator using TRS and clock outputs from the 1900 Series generator. Alternatively, the 1900 Series generator may be genlocked to the black burst output from the sync generator in the Digital Sweep Generator. A separate marker output provides identification of 1 MHz intervals, as well as 3.58 MHz and 4.43 MHz, during the sweep.

The Digital Sweep Generator is enclosed in a single wide TM 500 package. The front panel includes an LED power indicator, two 25-pin digital data connectors, three BNC connectors for blanking, markers, and black burst outputs, and one variable control to manually set CW frequencies. Digital interfaces of the DSG conform to the signal levels, clock rate and pinout of the proposed SMPTE standard.

When the Digital Sweep Generator is used in conjunction with a 1900 and an 015-0408-00 peak-to-peak detector (included accessory), it will provide an NBS-traceable analog frequency response standard and completes an effort to provide NBS-traceable performance verification of Tektronix television generators, waveform monitors, and other television equipment.

*[1] *The proposed SMPTE standard "Digital Format for a Parallel Interface (System M/NTSC)." draft of July, 1979.*

### CHARACTERISTICS

**Digital Sweep Output**

**Frequency Range** — 55.93 kHz to 7.159 MHz in 55.93 kHz increments; Field Sweep, or CW digital data.

**Format** — SMPTE Standard parallel 10-bit signal.

**Sample Clock Frequency** — 14.31818 MHz (4 fsc) ±100 Hz; also accepts external 14.3 MHz clock from 1900.

**Blanking** — Vertical: 22 lines to 23 lines. Horizontal: 10.8 μs.

**Markers**

1 V at 1.006747 MHz.

1 V at 2.013494 MHz.

1 V at 3.020241 MHz.

0.5 V at 3.579545 MHz.

1 V at 4.026988 MHz.

0.5 V at 4.418501 MHz.

1 V at 4.977805 MHz.

1 V at 5.984552 MHz.

Marker frequencies are multiples of 55.93 kHz.

**ENVIRONMENTAL**

**Temperature Range** — Operating: 0°C to +50°C. Nonoperating: −40°C to +65°C.

**Altitude** — Operating: To 4752 m (15,000 feet). Nonoperating: To 15 240 m (50,000 feet).

**Weights** — Net:0.6 kg (1.3 lb). Net Shipping: 1.3 kg (2.8 lb).

**INCLUDED ACCESSORIES**

ECL data cable assemblies (175-3671-00); 72 in low loss 75 Ω cable (012-0159-01); p-p detector (015-0408-00); manual.

### ORDERING INFORMATION

**Digital Sweep Generator.** Order 067-1011-00 ..... **$3,310**

**OPTIONAL ACCESSORIES**

**Detector Head.** Order 015-0407-00 ..... **$225**

## TEST MODULATOR

### High Quality Double-Sideband Modulator

### Available in Five Versions Covering Systems M, I, B, and G

### RF Output is −25 dBm ±3 dB

### IF Output is −24 dBm ±3 dB

### Separate Video and Aural Carrier Level Controls

### Group Delay Precorrection Systems M, B, and G

The 1450 Series Test Modulator is used to test a television demodulator plus down converter (system) or the television demodulator alone. Test modulators are available for four CCIR Systems and three visual IF Carrier Systems. The Test Modulator converts baseband video frequencies to a specified IF or RF. The aural carrier is below the visual carrier frequency at the IF output and above the visual carrier at the RF output.

Group delay precorrection (except System 1) and sound pre-emphasis switches are front panel mounted. The RF and IF outputs provide double-sideband modulated signals of high quality. State-of-the-art circuitry is used to achieve high accuracy and stability. The test modulator needs very little maintenance or recalibration.

### ORDERING INFORMATION

**Test Modulator,** 37 MHz for 1450-1. Order 067-0886-01 ..... **$4,275**

**Test Modulator,** 38.9 MHz for 1450-1. Order 067-0886-02 ..... **$4,275**

**Test Modulator,** 45.75 MHz for 1450-1. Order 067-0886-03 ..... **$4,275**

**Test Modulator,** 38.9 MHz for 1450-2. Order 067-0886-04 ..... **$4,275**

**Test Modulator,** 38.9 MHz for 1450-3. Order 067-0886-05 ..... **$4,275**

**Extender Cable**, for TDC/14501,-2,-3. Order 067-0899-00 ..... **$105**

**OPTIONAL ACCESSORIES**

**Half-Rack Adaptor Kit** — (Two instruments side-by-side.) Order 020-0633-00 ..... **$140**

**Half-Rack Adaptor Kit** — (One instrument and a "dummy" box, side-by-side.) Order 020-0634-00 ..... **$350**

## Other Calibration Fixtures for Tektronix Television Products.

### ORDERING INFORMATION

**GENERATORS**

**Diagnostic Prom** Order 067-0964-00 ..... **$125**

**690SR PICTURE MONITOR**

**Minimum Load Unit** — Order 067-0998-00 ..... **$175**

**Rigid Module Extender** — Order 067-0999-00 ..... **$50**

**Flexible Interface Module Extender** — Order 067-1000-00 ..... **$125**

**CRT Scale** — 11 x 15 line for 690SR, Option 40/42. Order 067-1034-00 ..... **$150**

**Pattern Generator** — Order 067-1039-00 ..... **$3,000**

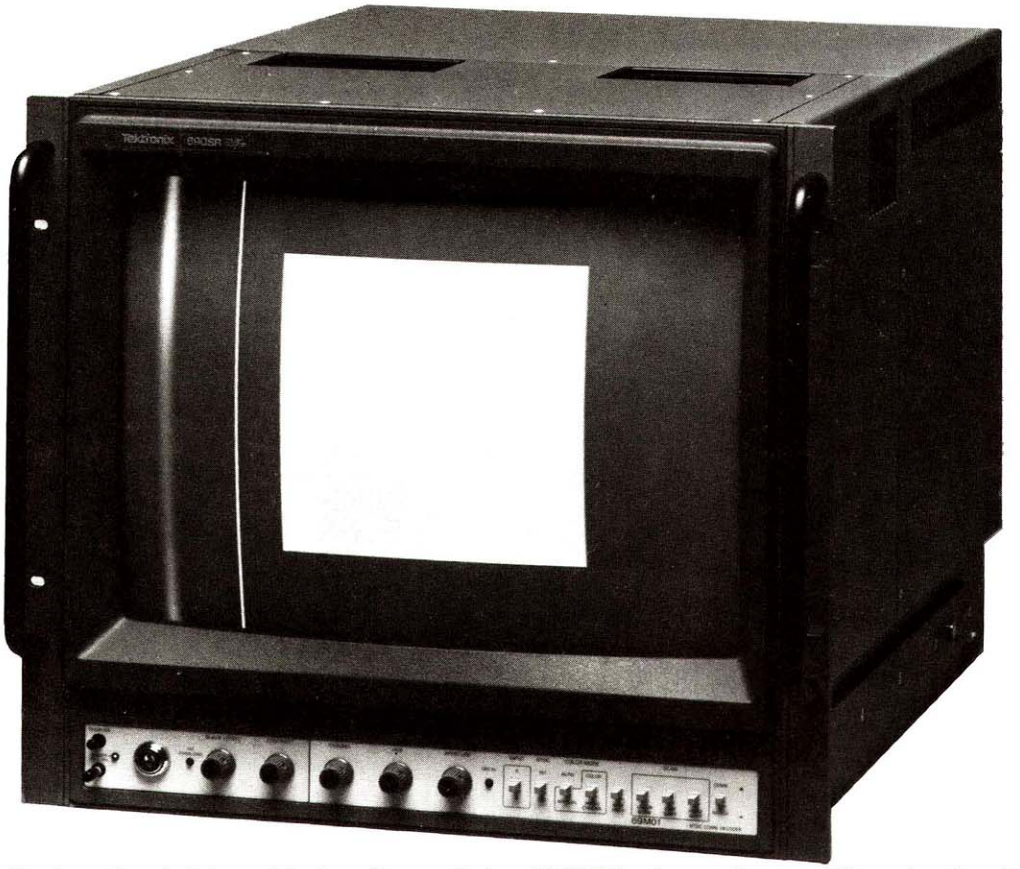
**CRT Scale** — 14 x 17 line for 690SR. Order 067-1054-00 ..... **$150**

**CRT Scale** — 15 x 20 line for 690SR. Order 067-1055-00 ..... **$150**

**1980 ANSWER**

**Service Kit** — for the 1980

**Tektronix Calibration Fixtures (067-XXXX-0X part numbers) are designed for calibration and verification of specific products. Some fixtures may not be supported at the same level as standard Tektronix products. Your local Tektronix Sales Office can advise you regarding availability and support.**



## 690SR Color Monitor

**High-Resolution 19-Inch Dot-Shadowmask CRT**

**Precise Color Convergence**

**Stabilized Color Balance**

**Rugged Modular Construction**

**Plug-in Interface (Decoder) Modules**

**Operates at Various Scan Frequencies**

**Adjustable Picture Size and Aspect Ratio**

The 690SR is designed to meet critical needs for image evaluation and video signal quality control in television, high definition television, and computer imaging environments. The standard high resolution delta gun, dot-shadowmask CRT and precise, stable video processing circuits provide faithful rendition of picture details and ease of closeup viewing. An optional medium resolution CRT provides more uniform screen appearance and tightly controlled phosphor colorimetry for those applications where greater viewing distance or signal limitations ease the requirement for the highest resolution display.

With either of these CRTs, Tektronix' unique color convergence system provides accurate color registration over the entire screen (less than 0.5 mm maximum error, equivalent to less than 0.18% of picture height) so that fine details can be observed anywhere in the picture. Stabilization of the operating point of each gun in the CRT compensates for tube aging and helps to maintain accurate long term color balance without frequent maintenance.

A logical and noninteractive set of convergence controls makes reconvergence a quick and straightforward task. All controls are identified by color-coded patterns and produce a comfortable up-down or right-left motion on the screen with negligible interaction. Several function switches are also located within the front drawer. In general, these switches permit the 690SR to be used either as an accurate picture/signal monitor to display faults if they are present, or as a high quality picture display monitor that provides a clean picture even in the presence of signal defects.

Front panel controls have detent positions so that the monitor may be returned to its preset condition quickly and accurately. Adjustments for the preset positions of front panel controls are located within the lockable front drawer together with virtually all other adjustments needed for routine setup.

Picture size can be adjusted from overscan to underscan without significant loss in convergence or linearity. This feature makes it possible to conduct experiments at various image sizes and aspect ratios or to set the monitor for different system characteristics by readjusting the size and position controls.

White balance is adjustable to standard D6500 or to other desired standards using controls located in the front drawer. A Setup switch allows the raster height to be reduced to facilitate low-level-light adjustments. Additional features in the television models include horizontal and vertical scan delays, and pulse cross. The CRT is automatically brightened in these modes to facilitate evaluation of blanking interval detail.

The 690SR mainframe is essentially an RGB monitor. The signal conditioning and/or decoding functions are performed in plug-in modular units. The 69M41 provides RGB input, with provision for external sync. The 69M01 is an NTSC decoder with a one line comb. The front control panel for each of these interface modules is also modular and is fitted into the control drawer of the mainframe. (A blank panel is provided with the 69M41 since no controls are needed for the RGB interface.)

All 690SR color monitors are fully enclosed and may be mounted in a standard relay rack. The 690SR complies with UL478 and UL1244, CSA Bulletin 556B, IEC348, and IEC435. The 690SR also complies, as of date of manufacture, with applicable DHHS standards under Radiation Control for Health and Safety Act of 1968 and with FCC/CBEMA standards for electromagnetic-interface control.

Various combinations of interface, CRT, and scan capability are orderable. The following "system" option allows convenient specification of a common configuration.

### 690SR OPTION 02

The 690SR Option 02 is a NTSC color monitor system that consists of a comb/notch filter/decoder module (69M01 Comb Decoder) installed in a 690SR mainframe.

### TV INTERFACE CHARACTERISTICS

**(Option 02, 69M01)**

**VIDEO INPUT**

**Amplitude** — 0.5 V to 2.0 V p-p composite video.

**Connector Type** — BNC.

**Return Loss** — 46 dB minimum to 5 MHz; loop-through compensated for 75 Ω (not internally terminated).

**Common-Mode Hum Rejection** — 50 dB minimum (with 4 V RMS mains hum applied to the shield and center conductor).

**LUMINANCE CHANNEL**

**Amplitude Linearity** — Within 2%.

**Bandwidth** — (Measured with aperture corrector off). 15 kHz to 10 MHz (with the chrominance filter removed).

*Note: The chrominance filter is automatically removed when Mode switch is in Auto position and burst is not present or when Mode switch is in Manual and Color Monochrome switch is in Monochrome.*

## 690 COLOR CRT SCREEN CHARACTERISTICS

| | Dot Pitch | Phosphor Screen | | Red X | Red Y | Green X | Green Y | Blue X | Blue Y | Application Information |
|---|---|---|---|---|---|---|---|---|---|---|
| Standard Product | 0.31 mm | Nominal | | 0.610 | 0.340 | 0.280 | 0.590 | 0.152 | 0.063 | Optimized for highest resolution and good brightness |
| | | Tolerance | | ±0.02 | | ±0.02 | | ±0.02 | | |
| | | Persistance | | Medium Persistance | | | | | | |
| Option 25 Television Display (US) | 0.43 mm | Nominal | | 0.630 | 0.340 | 0.310 | 0.595 | 0.155 | 0.070 | Optimized for good white field uniformity and tight chromaticity tolerance |
| | | Tolerance | | ±0.005 | | ±0.005 | | ±0.005 | | |
| | | Persistance | | Medium Persistance | | | | | | |

*Note: X, Y values are based upon 1931 CIE system*

**Aperture Corrector Range** — ≈6 dB boost available at 3.5 MHz or 7 MHz depending upon an internal jumper position.

**Chrominance Rejection** — ⩾20 dB at fsc.

**Dc Restoration** — Back porch negligibly affected by normal burst amplitudes.

### CHROMINANCE CHANNEL

**Demodulation Axis** — R-Y, B-Y.

**Bandwidth** — 3 dB down at 0.6 MHz and 10 dB down at 1.0 MHz.

**Gain Range** — −6 dB to +10 dB (preset at 0 dB).

**Chrominance/Luminance Timing Error** — 50 ns maximum.

**Residual Subcarrier Detection** — Three-position switch selects to display or not display color shift due to residual subcarrier; the third switch position causes color to shift at a 2 Hz rate for enhanced visibility when residual subcarrier is present.

**Blue Only** — Selectable from the front panel. When activated, all three output amplifiers are driven with the blue signal, resulting in a monochrome display. This enhances noise visibility and is useful for checking and adjusting chroma and hue controls using SMPTE Bar test signals.

**Color Bar Decoding Error** — ±3%.

**Display Modes** — Auto, Color, and Monochrome.

### SYNC AND TIMING

Stable subcarrier regeneration limited by line-sync performance; field sync stable with tilt = to 100% of sync amplitude in vertical blanking; field stable with 20 IRE mains hum.

**Modes** — Internal or external sync, selectable from the front panel.

**Input** — 0.5 V to 2 V p-p composite video or 0.2 V to 8 V p-p composite sync.

**Return Loss** — 46 dB minimum to 5 MHz; Loop-through compensated for 75 Ω (not internally terminated).

**Line and Field Sync White Noise Immunity** — 26 dB.

**Horizontal Jitter** — Typically 50 ns or less (Slow AFC Mode) with 1 V RMS of voltage mains hum, variable APL 10% to 90%, and −26 dB white noise.

**Vertical Jitter** — 1 μs p-p maximum; typically ⩽100 ns.

**AFC** — Switchable Slow/Fast; Slow AFC displays errors of incoming sync; Fast AFC largely corrects for incoming sync timing errors.

**Scan Delay** — Horizontal Delay: ≈one-third line time. Vertical Delay: ≈one-half field time. Display is intensified in delayed scan modes to enhance blanking and sync details.

**Underscan** — Switchable; factory-set to reduce size by 10%; adjustable range ≈1% to 15%.

## RGB INTERFACE CHARACTERISTICS (69M41)

### RGB VIDEO INPUTS

**Nominal Noncomposite Signal (External Sync Required)** — 0 V low light (black); 0.7 V high light for each RGB channel.

**Nominal Composite Signal (Internal Sync)** — 0 V low light (black); 0.7 V high light; −0.3 V sync. Sync may be present on each RGB channel, but internal sync is taken only from green channel.

**Maximum Allowable Signal Range** — Equivalent to the nominal levels ±6 dB (0.5 to 2X nominal p-p signal levels).

**Connector Type (BNC)** — Input Impedance: 75 Ω ±1% loop through or switch selectable internal termination; >15 kΩ unterminated.

**Return Loss** — 30 dB from 50 kHz to 25 MHz; 27 dB from 25 MHz to 50 MHz.

**Ac Coupled** — <1% line-time tilt for a 64 μs line.

**Back Porch Clamp Timing** — Clamp is active from a minimum of 0.54 μs to a maximum of 1.44 μs after the trailing edge of sync; vertical serrations must be at least 1.44 μs wide, if used.

**Pulse Response** — (10% to 90%) ⩽5.5 ns risetime or falltime.

### SYNC AND TIMING

**Input** — Internal and external sync; jumper selectable.

**External Sync Operating Input Range** — 100 mV to 8 V p-p adjustment range with composite sync applied to Comp Sync input connector. 400 mV to 8 V p-p adjustment range with composite video applied to Comp Sync input connector.

**Internal Sync Operating Input Range** — 400 mV to 2 V p-p adjustment range with composite video applied to Green input connector.

**Connector Type (BNC)** — Input Impedance: 75 Ω ±1% terminated loop through or switch selectable internal termination; >15 Ω unterminated.

**Return Loss** — 30 dB from 50 kHz to 10 MHz.

**Coupling** — Ac coupled and dc restored at sync tip.

**Sync Polarity** — Jumper selectable.

**Horizontal Timing** — RS-170, RS-330 or RS-343A sync; vertical serrated pulses and/or equalizers may be omitted; front porch not required (Block Sync).

**Horizontal Rates (AFC)** — 15 kHz to 38 kHz.

**Random Sync Jitter (p-p)** — <0.2% of horizontal period.

**Lock-In Range** — ±500 Hz without adjustment.

**Horizontal Position Adjustment Range** — > ±12% of horizontal period.

**Vertical Rates** — 43 Hz to 90 Hz.

**Vertical Sync Pulse Required** — >60 μs; <240 μs.

**Vertical Sync Random Jitter** — 0.2 μs p-p.

## MAINFRAME CHARACTERISTICS

### PICTURE

**CRT Size** — 19 in diagonal (nominal).

**Height** — 279 mm (11 in).

**Width** — 373 mm (14.7 in).

**Aspect Ratio** — 4:3.

**Phosphor Dot Triad Spacing** — 0.31 mm (standard); (see CRT options for other triad spacing).

**Convergence Error** — Maximum misconvergence 0.5 mm anywhere on the screen.

**Geometric Distortion** — ±1% within a circle bounded by screen height; ±1.5% anywhere else.

**Incremental Linearity Error** — ±1.8 mm (±0.07 in) over a nominal 25.4 mm (1 in) distance anywhere on the screen.

**White Colorimetry** — Factory-adjusted to Standard D6500; may be adjusted to other standards.

**Contrast (Light Output)** — Standard or Option 25 CRT: Highlight preset range 10 fL to 50 fL, maximum control range 6 to 62 fL.

**Gamma** — Determined by CRT (≈2.3).

**CRT Protect** — Failure of horizontal or vertical scan will turn off CRT high voltage supply.

**Blanking** — Vertical: ⩽600 μs. Horizontal: <6.75 μs.

### POWER REQUIREMENTS

**Input Voltage Ranges** — 103 V ac to 127 V ac or 207 V ac to 250 V ac.

**Frequency Range** — 48 Hz to 66 Hz.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 483 | 19.0 |
| Height | 444 | 17.5 |
| Depth | 579 | 22.8 |
| **Weights ≈** | **kg** | **lb** |
| Net | 50 | 110 |
| Domestic Shipping | 73 | 160 |

**Rackmounting Information** — Rear surface of monitor 559 mm (22 in) behind rackmounting surface, 690SR with interface module installed.

### ENVIRONMENTAL

**Operating Temperature** — 0°C to +50°C.

**Nonoperating Temperature** — −55°C to +75°C.

**Relative Humidity** — Operating: To 90% at +30°C (derated by 0.75% for each degree above +30°C). Nonoperating: To 90% at +60°C.

**Altitude** — Operating: Sea level to 4500 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).

### INCLUDED ACCESSORIES

8 ft power cord (161-0104-00); slide-out tracks w/mounting hardware (351-0395-00); two front drawer keys (214-3292-00); manual.

## ORDERING INFORMATION

**690SR** Color Monitor, (High Resolution (0.31 mm Triad Pitch) CRT ..... **$6,300**

### CRT OPTION

**Option 25** — Controlled Phosphor Colorimetry, Medium Resolution (0.43 mm Triad Pitch) CRT ..... **−$250**

### SYSTEM OPTION

**Option 02** — Standard Mainframe with 69M01 Installed ..... **+$765**

### INTERFACE MODULES

**69M01** NTSC Comb Decoder ..... **$850**

**69M41** RGB Interface ..... **$510**

### OPTIONAL ACCESSORIES

**Rigid Module Extender** — For circuit modules.
Order 067-0999-00 ..... **$50**

**Minimum Load Unit** — For power supply.
Order 067-0998-00 ..... **$175**

**Flexible Extender** — For interface modules/decoders.
Order 067-1000-00 ..... **$125**

**Linearity Graticule** — 11 x 15 lines.
Order 067-1034-00 ..... **$150**

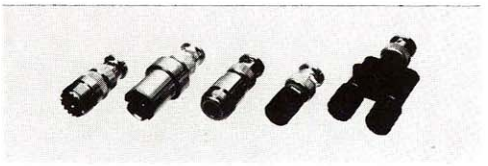
**Linearity Graticule (NTSC)** 14 x 17 lines.
Order 067-1054-00 ..... **$150**

**See this color product in the reference section beginning on page 17.**

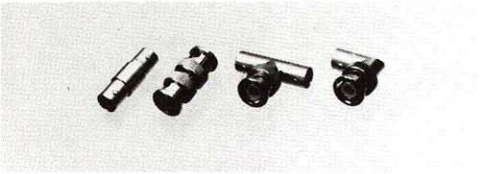
### ACCESSORIES FOR SPECTRUM ANALYZERS

**75 Ω Feedthrough Termination.**
**10 X Attenuator.** Order 011-0061-00 ..... **$32**
**50 Ω to 75 Ω Min Loss Attenuator.**
**75 Ω to 50 Ω Min Loss Attenuator, Ac Coupled.** Order 011-0112-00 ..... **$60**

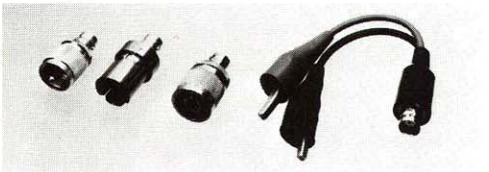
### ADAPTORS



**BNC — From Left to Right**
**Male to UHF Female.** Order 103-0032-00 ..... **$5.00**
**Male to GR.** Order 017-0064-00 ..... **$75**
**Male to N Female.** Order 103-0058-00 ..... **$7.00**
**Male to Binding Post.** Order 103-0033-00 ..... **$5.00**
**Male to Dual Binding Post.** Order 103-0035-00 ..... **$12**
**Female to Dual Banana.** (Not shown) Order 103-0090-00 ..... **$7.50**



**BNC — From Left to Right**
**Female to BNC Female.** Order 103-0028-00 ..... **$5.00**
**Male to BNC Male.** Order 103-0029-00 ..... **$5.50**
**T.** Order 103-0030-00 ..... **$6.50**
**Elbow Male to Female.** Order 103-0031-00 ..... **$7.50**

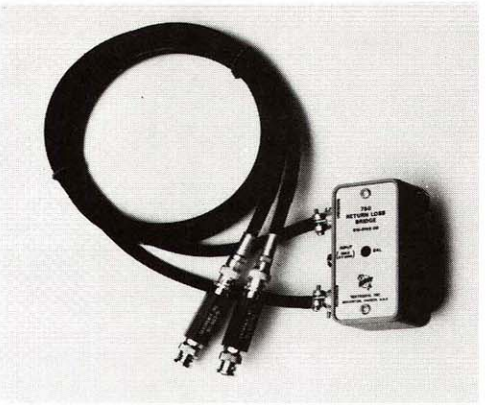


**BNC — From Left to Right**
**Female to UHF Male.** Order 103-0015-00 ..... **$4.50**
**Female to GR.** Order 017-0063-00 ..... **$43**
**Female to N. Male.** Order 103-0045-00 ..... **$6.50**
**Female to Clip Leads.** Order 013-0076-00 ..... **$25**

### BNC CABLES

**Coaxial**
**50 Ω, 18 in.** Order 012-0076-00 ..... **$17**
**50 Ω, 42 in.** Order 012-0057-01 ..... **$17**
**75 Ω, RG 59, 42 in.** Order 012-0074-00 ..... **$17.50**
**93 Ω, 42 in.** Order 012-0075-00 ..... **$29**
**75 Ω, 300 in (25 ft).** Order 012-0157-00 ..... **$100**
**75 Ω, Belden 8281, (6 ft).** Order 012-0159-01 ..... **$35**
**75 Ω, Belden 8281, (42 in).** Order 012-0159-00 ..... **$30**

### 75 Ω RETURN LOSS BRIDGE



This Return Loss Bridge is compact and rugged. It features passive components and simple construction. It is designed to measure impedance errors in a 75 Ω system in terms of return loss, using a wide-band, high-gain differential amplifier and oscilloscope (Tektronix 1A5/547 or 7A13/7000 Series) as the error detector. The Tektronix 011-0103-00 and 011-0103-01 are 75 Ω, 0.2% double-ended termination resistors supplied as removable bridge arms. Two matched coax cables extend the bridge arms and are permanently attached to the bridge. Either or both bridge arms can be disconnected for maximum flexibility, during calibration and in making measurements.

The bridge can be driven by a number of different sources such as TV test signals, squarewaves, sinewaves $\sin^2$ pulses, multiburst, swept frequency sinewaves. With the Return Loss Bridge coupled to the differential amplifier and oscilloscope, a television test signal such as the multi-burst can be used to measure impedance errors over the complete video spectrum with a single measurement.

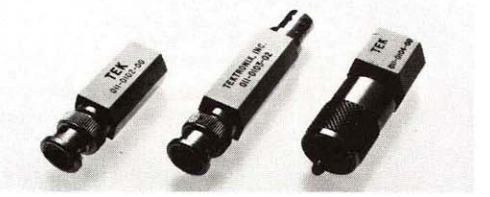
#### CHARACTERISTICS

**Return Loss** — ⩾54 dB, dc to 10 MHz.

**Max Input Voltage** — 6 V RMS (6 V RMS, dc to 1.2 MHz decreasing to 0.7 V RMS at 10 MHz when used with Type 1A5 or 7A13).

**Return Loss Bridge** — Order 015-0149-00 ..... **$360**

### TERMINATIONS



75 Ω termination. 75 Ω within 0.2% (at dc). Return loss is ⩾52 dB, dc to 10 MHz, maximum input voltage is 5 V RMS, center conductor to ground.

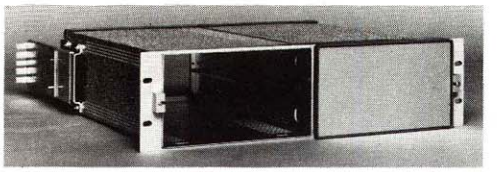
**BNC** — Order 011-0102-00 (left in photo) ..... **$16**
75 Ω feedthrough termination. 75 Ω within 0.2% (at dc). Return loss is ⩾52 dB, dc to 10 MHz maximum input voltage is 3 V RMS, center conductor to ground.

**BNC** — Order 011-0103-02 (center in photo) ..... **$23**

### FOR USE WITH 528A WAVEFORM MONITORS

**Rack Adaptor** — For side-by-side mounting of 528 Option 01's. Order 016-0115-02 ..... **$225**

**Panel Assembly** — For covering ½ of rack adaptor when only one 528 is rackmounted. Order 016-0116-00 ..... **$42**



Rack Adaptor 016-0115-02 with blank panel 016-0116-00 is used for mounting a 528 Option 01 Waveform Monitor, a 602 Option 01 Display Monitor, or a 1420 Option 01 Series Vectorscope in a standard 19 in rack. Without the blank panel two instruments can be mounted side-by-side.

### FOR USE WITH 1700 SERIES

**Carrying Case** — Painted (blue), with handle and feet. Order 390-0018-01 ..... **$85**

**Modular Carrying Case** — Portable case with handle, feet, and battery mounting lug's (lugs are required to mount the BPI). Order 020-1241-00 ..... **$120**

**Side-by-Side Rack Adaptor** — For mounting two half-racks (1740, 528A, etc) in a standard 19 in rack. Order 016-0115-02 ..... **$225**

**Blank Panel Assembly** — For one half of the side-by-side rackmount. Order 016-0116-00 ..... **$42**

**Snap-On Front Cover** — High impact plastic. Order 200-1566-00 ..... **$18**

**Use same descriptions as on individual pages of catalog (1740/1750).**

### CONVERSION KITS

**TSG1 to TSG7** — Order 040-1010-00 ..... **$375**

**1480C/1480R Option 01 X10 Probe** — Order 040-0769-00 ..... **$20**

**R520A Rack-to-Cabinet Conversion** — Order 040-1153-00 ..... **$50**

**1410R/1411 Rack-to-Cabinet Conversion** — Order 040-1152-00 ..... **$90**

**R147A/R148/R148M Rack-to-Cabinet Conversion** — Order 040-0573-00 ..... **$150**

## AUTHORIZED PROFESSIONAL VIDEO DEALERS

**ALABAMA**
**Birmingham**
Gray Communications Consultants, Inc.
Pro Video Systems, Inc.
Video Masters of Alabama, Inc.
**Mobile**
Gray Communications Consultants, Inc.
Pro Video Systems, Inc.
Video Masters of Alabama, Inc.

**ARKANSAS**
**North Little Rock**
Gray Communications Consultants, Inc.

**CALIFORNIA**
**Alameda**
Videotape Products, Inc.
**Berkeley**
General Electronic Systems, Inc.
**Glendale**
National TeleConsultants, Inc.
**Hollywood**
Shoreline, LTD
**Irvine**
Hoffman Video Systems
**Lawndale**
Omega Video, Inc.
**Los Angeles**
Hoffman Video Systems
Videotape Products, Inc.
**Palo Alto**
Merlin Engineering Works, Inc.
**Sacramento**
California Video Sales, Inc.
**San Diego**
Televideo San Diego
**San Francisco**
California Video Sales, Inc.
**San Jose**
Broadcast Marketing Associates
**Santa Clara**
California Video Sales, Inc.
**Sausalito**
R. E. Snader and Associates, Inc.
**Tarzana**
Gold Coast Video, Inc.

**COLORADO**
**Denver**
Video Teknix, Inc.

**FLORIDA**
**Clearwater**
Florida Video Systems, Inc.
**Ft. Lauderdale**
Florida Video Systems, Inc.
**Gainsville**
Gray Communications Consultants, Inc.
**Jacksonville**
Florida Video Systems, Inc.
**Miami**
Florida Video Systems, Inc.
Gray Communications Consultants, Inc.
Midwest Corporation
**Orlando**
Gray Communications Consultants, Inc.
**Ormond Beach**
Gray Communications Consultants, Inc.
**Tallahassee**
Florida Video Systems, Inc.
**Tampa**
Gray Communications Consultants, Inc.
Midwest Corporation

**GEORGIA**
**Albany**
Gray Communications Consultants, Inc.
**Atlanta**
ISACOMM, Inc.
Midwest Corporation
Technical Video Systems of Georgia, Inc.
**Doraville**
Gray Communications Consultants, Inc.
**Marietta**
Gray Communications Consultants, Inc.

**ILLINOIS**
**Elk Grove Village**
Swiderski Electronics, Inc.
**Morton Grove**
Roscor Corporation

**INDIANA**
**Indianapolis**
Dynavid Corporation
Midwest Corporation

**IOWA**
**Davenport**
Video Midwest, Inc.

**KANSAS**
**Shawnee Mission**
Broadcast Marketing Associates

**KENTUCKY**
**Edgewood**
Midwest Corporation
**Lexington**
Midwest Corporation
**Louisville**
Midwest Corporation

**MARYLAND**
**Baltimore**
Professional Products, Inc.
**Bethesda**
Professional Products, Inc.
**Lanham**
Midwest Corporation
**Rockville**
EMCO, Inc.
Peirce-Phelps, Inc.

**LOUISIANA**
**Harahan**
Gray Communications Consultants, Inc.

**MASSACHUSETTS**
**Boston**
Professional Video Systems
**Newton**
Lake Systems Corporation
**Waltham**
Landy Associates, Inc.

**MICHIGAN**
**Ann Arbor**
Thalner Electronic Labs, Inc.
**Oak Park**
General Television Network
**Troy**
Midwest Corporation

**MINNESOTA**
**Burnsville**
Emmons Associates, Inc.
**Minneapolis**
Todd Communications, Inc.
Video Midwest, Inc.

**MISSOURI**
**Chesterfield**
Television Engineering Corporation
**Kansas City**
Video Masters, Inc.
**St. Louis**
Delcom Corporation
VMI Company of St. Louis

**MISSISSIPPI**
**Jackson**
Pro Video Systems, Inc.

**NEW JERSEY**
**Cherry Hill**
Landy Assoicates, Inc.
**Mahwah**
Philips Television Systems, Inc.
**Mountain Lakes**
Turner Engineering, Inc.
**Northville**
A. F. Associates, Inc.
**Secaucus**
Panasonic, A-V Systems Division
**Teaneck**
Sony Broadcast Products

**NEW YORK**
**Buffalo**
Audio-Video Corporation
**Elmira**
Audio-Video Corporation
**Great Neck**
Instrument Mart
**Liverpool**
The Camera Mart, Inc.
**Menands (Albany)**
Audio-Video Corporation
**New York**
The Camera Mart, Inc.
MPCS Video Industries, Inc.
Reeves AV Systems, Inc.
Sonocraft Corporation
**Schenectady**
Professional Electronics Co.

**NORTH CAROLINA**
**Charlotte**
Midwest Corporation
**Winston-Salem**
Technical Video Systems, Inc.

**OHIO**
**Cleveland**
Midwest Corporation
**Columbus**
Midwest Corporation
**Dayton**
Kavco Incorporated
Midwest Corporation

**OKLAHOMA**
**Tulsa**
Delcom Corporation

**OREGON**
**Hillsboro**
Videosonics, Inc.
**Portland**
Custom Video Systems, Inc.

**PENNSYLVANIA**
**Camp Hill**
Peirce-Phelps, Inc.
**Carnegie**
Alpha Video & Electronics Co.
**Gibsonia**
Midwest Corporation
**Philadelphia**
Lerro Electrical Corp.
Pierce-Phelps, Inc.

**TENNESSEE**
**Bristol**
Midwest Corporation
**Hixson**
Midwest Corporation
**Knoxville**
Gray Communications Consultants, Inc.
**Nashville**
Gray Communications Consultants, Inc.
Midwest Corporation
Video Masters of Alabama, Inc.

**TEXAS**
**Amarillo**
Magnetic Media of Houston, Inc.
**Austin**
Broadcast Systems, Inc.
MZB & Associates
Magnetic Media of Houston, Inc.
Television Systems and Services
**Corpus Christi**
Video Systems, Inc.
**Dallas**
MZB & Associates
Magnetic Media of Houston, Inc.
SJB Distributors, Inc.
Video Systems, Inc.
**Houston**
MZB & Associates
Magnetic Media of Houston, Inc.
Video Systems, Inc.
**Lubbock**
Video Systems, Inc.
**San Antonio**
MZB & Associates
Video Systems, Inc.

**UTAH**
**Nekoosa**
Triax International Ltd.
Visual Technology, Inc.
**Salt Lake City**
Visual Technology, Inc.

**VIRGINIA**
**Richmond**
Midwest Corporation
Professional Products, Inc.
**Virginia Beach**
Midwest Corporation

**WASHINGTON**
**Mercer Island**
Bennett Engineering Associates, Inc.
**Seattle**
Custom Video Systems, Inc.
Videosonics, Inc.
**Spokane**
Northwest Electronics, Inc.

**WEST VIRGINIA**
**Nitro**
Midwest Corporation

**WISCONSIN**
**Nekoosa**
Todd Communications, Inc.

# COMMUNICATIONS NETWORK ANALYZERS

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**OF150** Fiber Optic Cable Tester ..... **198**
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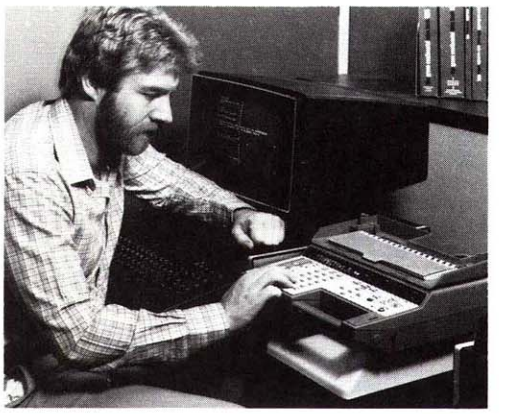
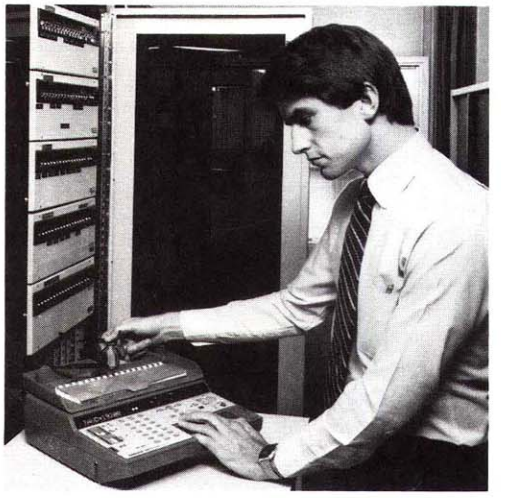
*Bisynchronous and SDLC/SNA Testing System*

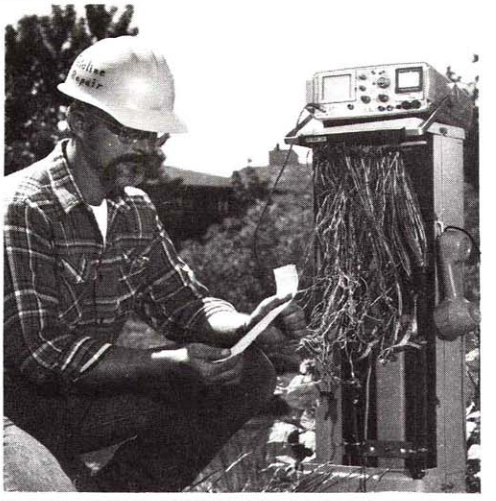


*Communications System Monitoring*

*Quality Assurance or Maintenance TDR (Time Domain Reflectometry)*



*Data Link Testing*



*Portable and Rugged TDR (Time Domain Reflectometry)*

## 834

**Programmable**

**Allows Automation of Tests**

**Easy to Operate**

**Handles ASYNC/ASYNC BLOCK/BISYNC/ HDLC/X.25/SDLC/SNA**

**Portable and Lightweight**

The Tektronix 834 Programmable Data Communications Tester is a powerful network troubleshooter designed to meet the demand for cost and time-effective first-line field service. The 834's portability (5.5 kg, 12 lb), ruggedness, and ease of use gives you a welcome independence from bulky, expensive equipment.

The 834 is compatible with EIA RS-232, and CCITT V.24 interfaces and can be expanded to many others with appropriate options. The 834 provides: system monitoring, DTE and DCE simulation to evaluate the entire network, bit error rate testing for analyzing phone lines and modems, the ability to calculate and confirm block check characters, and internal self-diagnostics.

The fast 19.2 kilobaud rate lets you test the most modern networks. The bright 16-character front panel display is fully decoded in ASCII, EBCDIC, HEX, your own, or optional character set.

We have programmed new features along with common test routines and setups into a series of application ROM packs that easily slip into the 834 and extend its testing capabilities in specific areas.

### MODES OF OPERATION

**Monitor**
The 834 monitors and records activity occurring on the interface without interfering with data transmission. The major control line status is recorded with each character. Trigger capability allows selective capture of data (refer to Triggering).

**Modem (DCE) Simulation**
In this mode, the 834 functions as DCE (Data Communications Equipment) or modem simulator for testing the DTE (Data Terminal Equipment). Messages can be sent to the UUT (Unit Under Test), and messages received from the UUT can be examined and cause further action by the 834. The sequence of events is controlled by a stored program (in the 834) which can be manually entered or stored in a user defined ROM (refer to Programmability).

**Terminal (DTE) Simulation**
In this mode, the 834 performs as DTE or terminal simulator for testing the DCE side of the interface. Otherwise, operation is similar to the modem (DCE) simulator mode described above.

**Bert Mode**
In this mode the 834 performs bit and block error rate testing using the 511-bit CCITT standard pseudo-random pattern. Additional patterns and testing capabilities are available with appropriate ROM pack.

**Self Test Mode**
In this mode, internal diagnostics and excercising routines can be called up by the operator to verify that the 834 is functioning properly.

## CHARACTERISTICS

### INTERFACE COMPATIBILITY

Compatible with EIA RS-232 and CCITT-V.24 interfaces. Optional interfaces also available.

### DATA TRANSFER

**Data Transmission Timing** — Synchronous and asynchronous.

**Communications Mode** — Half or full-duplex.

**Bits Per Character** — 5, 6, 7, 8, 9; characters with five bits do not include parity; characters with nine bits are available in asynchronous mode with parity.

**Codes** — ASCII, EBCDIC, HEX standard (others available with application ROM packs).

### DATA TRANSFER RATES

**Internal (Crystal Controlled)** — 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 7200, 9600, and 19,200 bits/s; (synchronous full-duplex up to ≤9600 bits/s).

**External** — Limited to maximum of 19,200 bits/s; (synchronous full-duplex up to ≤9600 bits/s).

**Parity** — None, odd, even, all mark, all space.

**RTS/CTS Delay (Half-Duplex Mode Only)** — Programmable from 0 ms to 9999 ms. (Defaults to 200 ms if not programmed.)

**Accuracy** — +5 ms, −15 ms.

**Block Check Characters** — CRC-16, CRC-CCITT, LRC; (expanded with ROM packs).

**Bit Error Rate/Block Error Rate Tests** — The 834 uses the 511-bit CCITT standard pseudo-random pattern sent in blocks of 1000 bits. Errors are counted continuously or over a test length of $10^5$ or $10^6$ bits stored in error, blocks sent, blocks in error, and sync faults. See 834R03A Link Test ROM Pack for additional capabilities.

### SET-UPS

### ASYNCHRONOUS OPERATION

**Stop Bits** — Transmits 1, 1.5 or 2; responds to 1.

**End of Frame** — One programmable character in any bit combination; (defaults to 0A); (ASCII New line).

**Timing** — Normal or isochronous.

### SYNCHRONOUS OPERATION

**Synchronizing Character** — Programmable to require any 1 or 2*[1] characters (defaults to 32 32).

**End of Frame** — Programmable to recognize any of a number of idle conditions (Mark, Space, Syn) and/or a single character (defaults to 37, EBCDIC EOT).

**Clock** — Normal, derived, DTE.

*[1] If 2, they may be different.*

### HDLC OPERATION

**NRZI** — On or off.

**Clock** — Normal, derived, DTE.

### TRIGGERING

**Trigger Location in Buffer** — Start, center, end.

**Match (Source of Data Being Searched for Trigger Events)** — None, DTE, DCE.

**Trigger Sequence** — Programmable to require a sequence of 0 to 25 characters (0 to 5 if no mask programmed).

**Mask Sequence** — Programmable to mask a 0 to 25 character trigger sequence.

**Error Conditions** — In Async: Parity or frame error. In Sync: Parity error. In HDLC: CRC error, abort sequence or short frame (<32 bits).

**Marker** — Low-to-high or high-to-low transition of marker can be selected.

**Buffer Capacity** — 2699 character (expanded with some ROM packs).

### PROGRAMMABILITY

**Program Steps** — 99 available.

**Message Lengths** — 50 totaling 3000 bytes.

**Data Captured** — Always the last 2699 character received before the program stops or before Stop is pressed; (number of characters expanded with some ROM packs).

**Basic Instruction Set (Additional Instructions Available in ROM Packs)**

HALT: mm

Stop and display message mm.

SEND: mm

Send contents of message buffer mm as a frame.

RECEIVE

Obtain next complete data frame for processing.

COMPARE: mm

Search frame for a match with message buffer mm.

JUMP EQ: ss

Jump to step ss if a match is found.

JUMP NE: ss

Jump to step ss if a match is not found.

JUMP: ss

Jump to step ss.

IF TIME: ss

Jump to step ss if the timer expires.

TIME OUT # pp

Start timer with value in parameter pp.

MASK: mm

Use message mm for mask during COMPARE operation.

WAIT # pp

Start time with value in parameter pp and do not proceed to following step until timer expires (10 to 9999 ms).

### INTERFACE ACCESS PANEL

**All Pins (2 through 25)** — Accessible.

**Major Control Lines** — May be connected or disconnected from the 834 via rocker switches. These include: TXD, RXD, RTS, CTS, DSR, GND, CD, TX0 (DCE), RX0 (DCE), DTR, TXO (DTE).

**Interface Configuration** — Can be modified using jumper straps and the +12 (space) and −12 (mark) V sources provided on panel. Control lines CD, RTS, CTS, DSR, and DTR are program controllable with most ROM packs.

**Probe** — Via a dual LED display, allows checking the current condition of any of the lines.

**Marker** — Allows the status of any interface line to be stored with each received character. This storage is in conjunction with the major control lines automatically recorded (CD, RTS, CTS). The marker, CD, RTS, CTS, DSR, and DTR can also be tested under program control with most ROM packs.

### DISPLAY

**Alphanumeric Display** — 16 fluorescent digits. (Each digit is a 5 x 7 dot matrix 9 mm high.)

**Status Indicator for Control Lines** — LED.

### PHYSICAL CHARACTERISTICS

| Dimensions ≈ | mm | in |
|---|---|---|
| Width | 305 | 12.1 |
| Height | 102 | 4.0 |
| Depth | 306 | 12.4 |
| **Weight ≈** | **kg** | **lb** |
| Net | 5.5 | 12.0 |

### POWER REQUIREMENTS

**Line Voltage Ranges** — 90 V ac to 132 V ac; 180 V ac to 250 V ac; 115 V nom.

**Line Frequency Range** — 48 Hz to 440 Hz.

### ENVIRONMENTAL CHARACTERISTICS

**Temperature Range** — Operating: 0°C to 50°C (32°F to 122°F). Nonoperating: −40°C to 75°C (−40°F to 167°F).

**Humidity** — 95% relative humidity, 30°C to 60°C.

**Altitude** — Operating: Sea level to 4500 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).

**Shock** — 50 gs, ½ sine. 11 ms duration in each major axis.

### OPTIONAL INTERFACES

**Current Loop Interface (Option 02)** — Operates in both two-wire (simplex or half-duplex) and four-wire (full duplex) modes. The current source for each of the two loops is selectable; either externally or internally supplied. Internal current sources are 20 mA and 60 mA.

**RS-449 Interface (Option 03)** — Supports both differential (RS-422) and single-ended (RS-423) circuits. This interface permits the use of a 9-pin connector for secondary channels along with the main 37-pin connector.

**MIL-STD-188C Interface (Option 04)** — Conforms to the military communication system technical standard MIL-STD-188C. Menu selectable, inverted or normal data allows the 834 to easily switch to an RS-232 compatible mode.

The MIL-STD-188C interface is factory installed only. The current loop and RS-449 interfaces are external PODS which can also be purchased as optional accessories and added at any time. When a POD interface is not connected, the standard RS-232 interface is functional.

**A6742 Two-Wire Direct Interface (TDI)** — An external assembly which provides an active interface between the 834 Data Communications Tester and the Two-Wire Interface Bus used in certain Burroughs Corporation Computer/Terminal Installations.

**A6743 RS-232/V.24 Tri-State Break-Out-Box** — An RS-232/V.24 interface break-out-box. The unit is battery powered and uses tri-state light emitting diodes (LEDs) to indicate the logic status of key interface circuits.

The LEDs show positive signals as red and negative signals as green. Invalid signals (voltages other than +3 volts to +25 volts or −3 volts to −25 volts) will not illuminate The LEDs.

The connectors for the DCE and DTE are both dual gender to allow hook-ups in any configuration.

The A6743 also contains a separate five position switch which allows the user to quickly swap lines 2 and 3 for modem reversal or to apply positive voltage to either CTS, DSR, or DCD for test applications.

**INCLUDED ACCESSORIES**

RS-232 three connector cable assembly, front panel jumper set (198-4006-00); U.S. 115 V power cord (161-0066-00); operators manual.

## ORDERING INFORMATION

**834** Programmable Data Communications Tester ..... **$3,990**

**Option 02** — Current Loop Interface ..... **+$325**
**Option 03** — RS-449 (RS-422/RS-423) Interface ..... **+$750**
**Option 04** — MIL-STD-188C ..... **+$350**
**Option 05** — A6742 Interface ..... **+$395**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A
**Option A2** — UK 240 V/13 A
**Option A3** — Australian 240 V/10 A
**Option A4** — North American 240 V/15 A

**ROM PACKS**

**834RDA** — ROM Development Aid ROM Pack ..... **$450**
**834R01** — General Purpose ROM Pack ..... **$280**
**834R02A** — Bisynchronous ROM Pack (EBCDIC) ..... **$350**
**834R03A** — Link Test ROM Pack ..... **$370**
**834R04** — HDLC/X25 ROM Pack ..... **$450**
**834R05** — Extended Instruction Set ROM Pack ..... **$175**
**834R06** — Bisynchronous ROM Pack (ASCII) ..... **$350**
**834R07** — PARS/IPARS ROM Pack ..... **$375**
**834R10** — SDLC/SNA ROM Pack ..... **$450**
**834R11** — Extended Monitor ROM Pack ..... **$425**
**834R13** — SDLC/SNA (FID3) ROM Pack ..... **$450**

**OPTIONAL ACCESSORIES**

**Current Loop Pod Accessory** — Order 015-0361-00 .. **$350**
**RS-449 Interface** — Order A6741 ..... **$750**
**Two Wire Direct Interface** — Order A6742 ..... **$395**
**Break Out Box** — Order 015-0258-00 ..... **$190**
**Diagnostic ROM Pack** — Order 067-0986-00 ..... **$480**
**Carrying Case** — Order 016-0672-00 ..... **$80**

A variety of training accessories are also available including workbooks, videotapes, etc.

Additional information available in the 834 Selection Guide (request number 35-W-4922-3). Request copies at your local sales office or via the return card in this catalog.

# 834RDA

## The System for Developing Customer User ROMs for 834 ROM Packs

The Tektronix 834RDA is the tool that gives users the ability to automate and extend the capabilities of the 834 Programmable Data Communications Tester by developing custom application ROMs for use with 834 application ROM packs.

The 834RDA supports the generation of user-defined programs, setups and messages. It also aids the user in extending the Baud, Code, Idle and transfer function directory menus by adding new menu entries.

PROMs are developed by building a ROM image in the 834 System. The ROM image is the entire contents of the ROM you are creating, including all the messages, programs, power-up setups and transfer functions that you develop. The 834RDA uses the RS-232 or an optional port on the 834 to interface to an external PROM programmer, a printer or terminal, or a unit under test. The 834RDA and 834 are used with an external PROM programmer to read and write PROMs. A terminal or printer used with the system produces formatted listings of the ROM image contents. With the 834 connected to the unit under test, the ROM image can be executed to verify operation and correctness.

The 834RDA also contains the Extended Instruction Set available in most 834 ROM packs.

### FUNCTIONS OF THE ROM DEVELOPMENT AID

**Save Program/Setup Function**
The Save Program/Setup Function provides an easy method of saving individual instrument setups or simulation programs for storage in ROM. These setups and simulation programs will be callable by the user, or may be called up by preprogrammed test routines.

**Record Mode**
In Record Mode all keystrokes are recorded in the order that they are entered until the exist command is executed. Afterwards, the keystroke sequences may be edited. Record Mode is particularly useful for preprogramming 834 operations or test routines. It can also be used to create individual instrument setups or simulation programs for storage in ROM. The user can also easily set up automated test sequences in Record Mode by the call-up of previously programmed instrument setups and simulation programs.

**Form Entry Functions**
Several types of entries can be created using the Form Entry Functions. These include menu additions (baud rates, translation code tables, directory entries, and sync idle characters); keystroke sequences (power up and normal); character strings (for addition to message buffers). These functions can also be used to edit or modify existing programs or routines.

**New Key Codes**
The 834RDA includes two additional Code menu items. The Keys translation code produces a one-character representation of each key and is used when editing key sequences. The Display translation code makes all 834 display characters available to the user for building new code translation tables.

**Input-Output Functions**
The 834RDA System can accept input from any PROM burner that supports the TEK HEX format and has an RS-232 interface. Error detection checks are made to assure correct image transfer from the PROM programmer to the 834. The ROM image contains all of the completed entries plus the appropriate "overhead" data such as header, trailer, byte counts and checksum information. Upon completion of new entries or changes to the ROM image contents, the 834RDA ROM Development Aid can send a completed ROM image back to the PROM burner.

A listing of the entire ROM image or of individual entries can be sent to a printer or terminal for documenting purposes.

**834RDA Menu**
Level 1:
Copy Entry, Replace Entry, Delete Entry, Write 2 k, Write 4 k, Read ROM, Clear ROM, Print ROM.

Level 2:
HDR:, Size =, (list of additional entries as created).

Level 3:
Form Keys, Form Messages, Form Directory, Form Baud, Form Idle, Form Code, Form Pupkeys.

**Program Edit Functions**
The program edit functions enable users to insert and delete program steps. The resulting program is automatically renumbered to reflect the changes and all Jump and Call instructions will be adjusted accordingly.

**Program Debug Functions**
The program debug functions enable users to interrupt an executing 834 program, cause single-step program execution, set a breakpoint and display or change program steps, parameters, and messages.

### ADDITIONAL INFORMATION

The 834RDA should be used with an 834 having level 05 or greater software. This can be verified by placing the 834 in self-test mode; scrolling down two levels to the LIST-DSROM display, then over one entry to LIST-CSROMØ. Press the start key; the display will read "CSRMØ;PN=Ø836-Ø5" or similar. This is the part number of the ROM containing the pertinent 834 software, and the last two digits should be 05 or greater.

A level 05 or greater ROM is supplied with each RDA in case it is needed. If it is not, the ROM can be erased and used for recording your custom routines.

If additional information or updates are required, contact your local Tektronix Sales or Service Center.

The 834RDA System is compatible with several PROM burners. Tektronix Application Note 35AX-4780 is available with additional detail on PROM programmer compatibility, selection criteria and operation information.

## ORDERING INFORMATION

**834RDA** ROM Pack Development Aid .. **$450**

**Option 01** — adds the following instructions to the 834RDA: PACKFRAME, HEX CONVERSION, AND, OR and deletes the Print ROM function available in the standard 834RDA .... **N C**

## 834 ROM Packs

834 ROM packs are firmware extensions of the 834 Programmable Data Communications Tester. These products all contain the extended instruction set as listed on this page. They (except the 834R01) also include program debug and edit functions plus the unique capabilities listed for each individual ROM Pack.

Additional information is available in the 834 Selection Guide (request number 35W-4922-3). Request copies at your local sales office or via the return card in this catalog.

In each ROM Pack, at least one ROM space is reserved for customer use. Each ROM space can accommodate a 2 k or 4 k ROM or EPROM. The custom ROM area of the ROM Pack can be programmed using 2716, 2732, 2516 or 2532 single power supply EPROMs or combination of the above.

As new ROM Packs have been introduced and existing ROM Packs enhanced, the firmware in the 834 has been expanded. The description for each ROM Pack includes the 834 firmware revision level required to make available all the capabilities of the ROM Pack. New 834's are shipped with the latest firmware and will support all the 834 ROM Packs in this catalog.

The software level of older 834s can be easily verified as follows:
Place 834 in Self-Test mode.
Scroll down two levels (press ↓ key twice) to the LIST DSROM display.

Press the → key once to obtain the LIST CSROMØ display.

Press Start key.

The display will read CSROMØ=PN=Ø836-XX. The last two digits indicate the software level of the 834 Data Communications Tester.

Contact your local Tektronix Sales or Service Center if additional information or updates are required.

**Extended Instruction set,**

**11 LOAD # pp**
Load register with value in parameter PP

**12 STORE # pp**
Store register value in parameter PP

**13 COMPARE # pp**
Compare register value to value in parameter PP

**14 INCRMNT # pp**
Increment value in parameter PP by one

**15 DECRMNT # pp**
Decrement value in parameter PP by one

**16 DISPLAY # pp**
Display value in parameter PP

**17 LOAD: mm**
Load register with character from message MM

**18 STORE: mm**
Store register value in message MM

**19 DISPLAY: mm**
Display message MM

**20 CLEAR: mm**
Clear message MM

**21 TRANSFR # pp**
Invoke key sequence described by value in parameter PP

**22 SETEIA = nn**
Set EIA RS-232 control line specified by value NN

**23 TESTEIA = nn**
Test EIA RS-232 control line specified by value NN

**24 TESTFRM = nn**
Test for type of frame indicated by value NN

**25 TESTKEY = nn**
Test for keyboard input indicated by value NN

**26 BREAK # pp**
Send BREAK for length of time specified in parameter PP

**27*1 BCC: mm**
Calculate and insert BCC for message MM

**28*1 PROTOCOL**
Enables customized BCC calculation for particular protocols and translation codes

**29*1 BLOCK: mm**
Compare frame to message buffer MM and count bit errors

**30*1 CLEAR # pp**
Set contents of parameter PP to zero

**31*1 CALL→ss**
Program execution continues at step SS after placing the number (SS+1) in the register.

**32*1 RETURN # pp**
Program execution continues at step number contained in parameter PP

**33*1 OVERLAY # pp**
Invoke transfer function xx, where xx is the contents of parameter PP

**In addition to the Extended Instruction Set, the following instructions are resident in selected ROM packs.**

**34 PACKFRM: mm**
Pack control field data into message mm, or, if mm = 0, unpack control field data from received HDLC/SDLC frame.

**35 HEXCONV : mm**
Convert an item in the register to the hexadecimal value of the item; add the hexadecimal character string to message mm.

**36 AND # pp**
AND the contents of the register with the value in parameter pp, then place the ANDed value in the register.

**37 OR # pp**
OR the contents of the register with the value in parameter pp; then place the ORed value in the register.

**1 Not in 834R01*

## 834R01 General Purpose ROM Pack

The 834R01 ROM Pack*1 simplifies and expands operation of the 834 Data Communications Tester for use with asynchronous systems.

The following capabilities are programmed into the 834R01 ROM Pack:

- Sets up conditions for asynchronous operation upon instrument power up.
- The addition of correspondence and Baudot character decode tables.
- Additional idle menu selections.
- Split baud rate capability allows either the transmit or receive baud rate to be changed. Basic printer tasks verify:
  - That characters are positioned and printed properly. Also evaluates DTR response and X-on, X-off feature.
- Simulate and repeat modes (with and without trigger).
- Correspondence code setup (sets the 834 to the most common correspondence setup).
- Baudot code setup (sets up the 834 for the most common Baudot code setup).
- Block asynchronous setup (sets up the 834 to operate in the block-asynchronous mode).
- Graphic test patterns for calibrating screen attributes in Tektronix 4010 Series terminals.
- Extended instruction set through the BREAK instruction (#26).

**1 Level 3 or higher 834 software required.*

## 834R02A
### Bisynchronous (EBCDIC) ROM Pack

## 834R06
### Bisynchronous (ASCII) ROM Pack

The 834R02A and 834R06 ROM Packs*1 extend and simplify the use of the 834 in exercising components of the IBM 3270 Information Display System family and compatible terminals manufactured by other companies.

The following capabilities are provided in an EBCDIC version in the 834R02A*1 and ASCII in the 834R06:

- Frame Summaries to provide frame level mnemonic summary on a frame-by-frame basis. (This enables the user to quickly and easily step through data a frame at a time while viewing straight forward descriptions rather than sorting through long streams of data.)
- Automated BCC checking and insertion
- Preprogrammed common bisync messages
- Terminal setup and status tests
- Attribute Exercise Pattern for testing screen attributes and orders of a video display terminal.
- Multiple alignment patterns for video displays
- New line/End-of-message patterns for testing printers
- Control Key Response test
- Various utility programs
- Extended instruction set, plus Hex conversion
- The AND instruction, and the OR instruction

**1 Level 5 or higher 834 software required.*

**OPTION 12**

Option 12 (for the 834R02A, 834R06, 834R10 and 834R13 ROM packs) incorporates the software to support down loading of programs from a remote host to the 834. Option 12 also includes a logon application program specific to ATT requirements. Coupling between the 834 RS-232 port and transmission line will require a user supplied modem.

## 834R03A Link Test ROM Pack

The 834R03A ROM Pack*1 extends the Data Communications Link testing capability of the 834.

The following Bit Error Rate Test (BERT) patterns are provided in the 834R03A ROM Pack:

- User defined (may be 4 bytes to 3000 bytes in length)
- 2047-bit pseudo-random pattern
- 63-bit pseudo-random pattern
- 511-bit pseudo-random (CCITT V.25) pattern sent in block sizes of 511 bits instead of 1000
- Continuous space
- Continuous mark
- Alternating spaces and marks
- 3 spaces alternating with 1 mark
- 1 space alternating with 3 marks
- 7 spaces alternating with 1 mark
- 1 space alternating with 7 marks

Additional test lengths:
- 10 kilobits
- 10 megabits
- Timed termination

Independent transmit and receive baud rates
Over and under baud rate deviation tests (±1, 2.5%)
Turn around delay measurement
Control line tests
Full and Half duplex ping-pong tests
Half duplex BERT
Bias distortion test
Gross start-stop distortion test
Individual start-stop distortion test
Isochronous distortion test
Extended Instruction set

*¹ Level 4 or higher 834 software required.*

## 834R04 HDLC/X.25 ROM Pack

The 834R04 ROM Pack*¹ expands the operational scope of the 834 when monitoring and simulating HDLC and X.25 packet switching networks and their components.

**The following capabilities are included in the 834R04 ROM Pack:**
- Frame-by-frame analysis of data exchanges
- Packet-by-packet analysis of data exchanges
- Construction of HDLC-formatted frames under applications control
- LAP and LAPB setup-shutdown tests
- Extended instruction set
- Packfram instruction
- Option 01 (Factory installed only) makes the 834R04 compatible with HDLC networks using Bisync Framing.

*¹ Level 5 or higher 834 software required.*

## 834R05 Extended Instruction Set ROM Pack

The 834R05 ROM Pack*¹ is for users with unique application requirements that cannot be fulfilled by the standard application programming included in other ROM Packs. The 834R05 contains the extended instruction set and program debug and edit functions. The remainder of the ROM Pack is reserved for user application ROMs.

The 834R05 reserves room for three user ROMs.

*¹ Level 4 or higher 834 software required.*

## 834R07 PARS/IPARS ROM Pack

The 834R07 ROM Pack*¹ expands the operation of the 834 Data Communications Tester for testing programmed airline reservation systems.

**The following capabilities are included in the ROM Pack:**
- SABRE translation
- Reversed Hexidecimal translation
- Inverted data capabilities
- Direct Poll — Continually sends a Go-Ahead message and looks for replies after each poll.
- 768 E-Pattern (64 x 12) for terminal alignment
- 960 E-Pattern (64 x 15) for terminal alignment
- 65 Character Print (64 x 12) "Stairstep" pattern
- Reset Terminal — Sends terminal reset command (3E HEX) to interchange unit to effect erasure of all terminal screens.
- Terminal Echo — Polls an interchange and when text message is received, echoes that message back to the originating terminal.
- Printer Test — Tests new line function
- Terminal Simulation — Responds to direct polls, write, erase/write commands, and unsolicited message commands.
- ASCU Set-ups — For communicating to Agent Set Control Unit Equipment
- Extended Instruction Set

*¹ Level 4 or higher 834 software required.*

## 834R10 SDLC/SNA (FID2) ROM Pack

The 834R10 ROM Pack*¹ enhances the capabilities of the 834 when operating in an SDLC/SNA environment using format identifier type 2. This ROM Pack provides easy to read SDLC frame and SNA command summaries. This allows quick and straightforward analysis of data transactions.

**The following capabilities are included in the 834R10 ROM Pack:**
- Attribute tests for 3274 and 3276 displays
- Display alignment pattern
- New-Line/End-of-Message pattern for testing printers attached to 3274s and 3276s.
- Control Key Response Test
- Extended Instruction Set, plus
- HEX conversion
- AND instruction
- OR instruction

*¹ Level 5 or higher 834 software required.*

## 834R11 Extended Monitor ROM Pack

The 834R11 ROM Pack*¹ implements more powerful monitoring functions. It allows the recognition of events to cause programmable actions rather than simply triggering the 834. Using event-action pairs provides the mechanism for manipulating counters and timers that facilitate statistical analysis of interactions or events within a network as well as complex triggering.

There are three event-action pairs available with this ROM Pack plus a timeout-action pair that activates when an event does not occur within a specified time.

The 834R11 does not require the extended instruction set.

**834R11 ROM Pack event selections:**
- DCE Messages with or without masking
- DTE Messages with or without masking
- Error
- Selected Control line change

**834R11 ROM Pack action selections:**
- Trigger the 834
- Decrement or increment specified counter
- Start interval timer
- Enable event-action pairs
- Disable all actions except Enable

*¹ Level 5 or higher 834 software required.*

## 834R13 SDLC/SNA (FID 3) ROM Pack

The 834R13 ROM Pack*¹ enhances the capabilities of the 834 when operating in an SDLC/SNA environment using format identifier Type 3. This ROM Pack provides easy-to-read SDLC frame and SNA command summaries. This allows quick and straightforward analysis of data transactions.

**The following capabilities are included in the 834R13 ROM Pack:**
- Attribute tests for 3271 Control Unit Models 11 and 12, 3275 Display Station Models 11 and 12.
- Display alignment pattern
- New-Line/End-of-Message pattern for testing printers attached to 3271s and 3275s
- Control Key Response Test
- Extended Instruction Set, plus
- HEX conversion instruction
- AND instruction
- OR instruction

*¹ Level 5 or higher 834 software required.*

### ORDERING INFORMATION

**834R01** General Purpose ROM Pack .... **$280**
**834R02A** Bisynchronous ROM Pack (EBCDIC) ..... **$350**
**Option 12** — Download with ATT Application ..... **+$60**
**834R03A** Link Test ROM Pack ..... **$370**
**834R04** HDLC/X.25 ROM Pack ..... **$450**
**Option 01** — Bisynchronous Framing ..... **+$50**
**834R05** Extended Instruction Set ROM Pack ..... **$175**
**834R06** Bisynchronous ROM Pack (ASCII) ..... **$350**
**Option 12** — Download with ATT Application ..... **+$60**
**834R07** PARS/IPARS ROM Pack ..... **$375**
**834R10** SDLC/SNA (FID2) ROM Pack .. **$450**
**Option 12** — Download with ATT Application ..... **+$60**
**834R11** Extended Monitor ROM Pack .. **$425**
**834R13** SDLC/SNA (FID 3) ROM Pack . **$450**
**Option 12** — Download with ATT Application ..... **+$60**

Additional information available in the 834 Selection Guide (request number 35W-4922-3). Request copies at your local sales office or via the return card in this catlog.

# METALLIC TDR CABLE TESTERS

**Portable** — Battery Powered, Self Contained, Lightweight

**Rugged** — Meets MIL-T-28800, Type III, Class 3, Style A

**Versatile** — Test Any Type Paired Conductor and Coax Cable

**Easy to Use** — Produces Results with Minimal Operator Training

## Time Domain Reflectometry TDR*[1]

The portable, rugged 1502 and 1503 TDR Cable Testers are field maintenance tools that are simple to operate and will test any transmission cable under virtually any conditions. The 1502 is appropriate for testing coax and other cables in aircraft, ships, radar sites, etc. The 1503 tests long runs of coax or twisted pair cables in telephone and other communications applications.

These units use a technique called Time Domain Reflectometry (TDR) to identify and locate cable faults. When connected to a line in the cable, the unit sends out an electrical pulse that is reflected back to the unit by a fault in the cable. Fault type is identified by the shape of the display, and fault distance is determined by the displayed interval from the test pulse to the fault pulse.

For easy carrying and operating in tight spaces, these units are lightweight and small and will operate at least five hours on the internal, rechargeable batteries.

Since permanent records are useful in cable maintenance, an optional, plug-in chart recorder is available for paper recording of the test. The standard plug-in X-Y output module can drive an external X-Y Recorder.

### 1502

This unit is directly calibrated in reflection coefficient (rho) and distance. The 1502 uses a step-pulse and provides fault resolution to 0.6 inch on short cables. The 1502 performs to a maximum of 2000 feet, but with decreasing resolution as the fault distance increases. The unit is matched to 50-ohm cables, but may be used on others by adjusting the front panel GAIN control or using optional impedance adaptors.

### 1503

For long cables, the 1503 provides high-energy, ½-sine-shaped pulses. Range of the 1503, dependent upon cable type, is up to 50,000 feet. Resolution capability provides for resolving faults as close together as three feet on short cables. Impedance levels of 50, 75, 93 and 125 ohms are selectable.

### 1503 Option 01

1503 Option 01 has Distance Cal switches that make it more convenient for fault location in a variety of cables including coax. When the 1503 Option 01 has been calibrated for each cable before trouble occurs, and the records are kept, the Distance Cal switches can be set exactly and damage location can begin immediately.

### Metric Instruments (1502, 1503)

For distance measurements in meters, instead of feet, Option 05 is available for both the 1502 and 1503. These instruments are fully metric versions of the 1502 and 1503 with no conversion from feet to meters involved.

The 1502 Option 05 has a distance resolution of 15 mm and measures 500 meters.

The 1503 Option 05 has a resolution of 0.9 meter and measures 10 000 meters.

*[1] Also known as cable radar.*

## 1502 Short Range TDR Cable Tester

### CHARACTERISTICS

#### TEST SIGNAL

**Shape** — Step rise.
**Amplitude** — 225 mV nominal (into 50 Ω load), dc coupled.
**Aberrations** — Within ±5% during 1st 10 ft after rise. Within ±0.5% peak beyond 10 ft Noise Filter "out."
**System Reflected Rise** — ≤0.07 ft (≤140 ps).
**Jitter** — ≤0.02 ft (≤40 ps) for X.1. ≤0.1 ft (≤200 ps) for X1.
**Test Connector** — BNC.
**Termination** — 50 Ω, within ±2%.
**Maximum Input** — DO NOT APPLY EXTERNAL VOLTAGE.

#### VERTICAL SYSTEM

**Display Range** — ±4 div.
**Accuracy** — Within ±3%.
**Calibration Point** — 2 div = 1 ρ.
**Deflection Factor** — 5 mρ/div to 500 mρ/div, 7 steps, 1-2-5 sequence.
**Variable** — ≥3.5:1 from calibration point.
**Displayed Noise** — Noise Filter Switch "Out": ±5 mρ or less. Noise Filter Switch "In": ±2 mρ or less.

#### HORIZONTAL SYSTEM

**Distance Controls**
**Distance Dial** — Range: 0 ft to 100 ft for X.1. 0 ft to 1000 ft for X1. Accuracy: Within ±2% of reading ±0.05 ft for X.1. Within ±2% of reading ±0.5 ft for X1.

**Feet/Div Control** — Range: 0.1 ft to 20 ft/div for X.1. 1 ft to 200 ft/div for X1. Accuracy: Within 2% of full CRT screen.

**Cable Dielectric Scales (Vρ/Vair)** — Solid Poly, 0.66; Solid PTFE, 0.70; Other Var, 0.55 to 1.0. Var is calibrated for air when turned fully cw.

**Sweep Repetition** — 40 Hz within +0 Hz, −10 Hz with Noise Filter Switch "Out." 4 Hz within ±20% with Noise Filter Switch "In". 20 s/sweep nominal in chart recorder mode (dependent upon chart recorder).

#### UNIQUE CHARACTERISTICS (1502 OPTION 05)

#### TEST SIGNAL

**Aberrations** — Within ±5% during 1st 300 cm after rise. Within ±0.5% peak beyond 300 cm Noise Filter "Out."

**System Reflected Rise** — ≤2.1 cm (≤140 ps).

**Jitter** — ≤0.6 cm (≤40 ps) for X.1. ≤3 cm (≤200 ps) for X1.

#### HORIZONTAL SYSTEM

**Distance Controls**
**Distance Dial** — Range: 0 m to 25 m for X.1. 0 m to 250 m for X1. Accuracy: Within ±2% of reading ±0.02 m for X.1. Within ±2% of reading ±0.2 m for X1.
**Meters/Div Control** — Range: 0.025 m/div to 5 m/div for X.1. 0.25 m/div to 50 m/div for X1.

## 1503 Long Range TDR Cable Tester

### CHARACTERISTICS

#### SINEWAVE TEST SIGNAL

**Shape** — ½ sine within ±20%.
**Amplitude** — 10 V ±20% unterminated. 5 V ±20%, terminated, ac coupled.
**Aberrations** — −30 dB p-p. (Equivalent to ±1.6%).
**Duration** — ≤10 ft (10 ns),*1 ≤100 ft (100 ns),*1 ≤1000 ft (1000 ns).*1
*1 *Duration times are within ±20% at half amplitude.*
**Jitter** — ≤1 ft for X10 (≤2 ns). ≤10 ft for X100 (≤20 ns).
**Test Connector** — BNC.
**Termination** — 50 Ω, 75 Ω, and 93 Ω, within 1%; 125 Ω within 3%.
**Maximum Input** — ±400 V (dc + peak ac at maximum frequency of 440 Hz).

#### VERTICAL SYSTEM

**Display Range** — ±4 div.
**Accuracy** — Within ±0.25 dB (within ±3%).
**Calibration Point** — 2 div = 0 dB.
**Deflection Factor** — 0 dB to 60 dB, 7 steps, 10 dB per step.
**Variable** — 0 dB to 18 dB additive to steps.
**Displayed Noise** — Noise Filter Switch "Out": −80 dB RMS, random. Noise Filter Switch "In": −86 dB RMS, random.

#### HORIZONTAL SYSTEM

**Distance Controls**
**Distance Dial** — Range: 0 ft to 2,500 ft at X10. 0 ft to 25,000 ft at X100. Accuracy: Within 2% of reading ±2 ft for X10. Within 2% of reading ±20 ft for X100.
**Feet/Div Control** — Range: 5 ft/div to 500 ft/div at X10. 50 ft/div to 5000 ft/div at X100. Accuracy: Within 2% of full CRT screen.
**Cable Dielectric Scales (Vρ/Vair)** — Solid Poly: 0.66. Foam Poly: 0.81. Var: 0.31 to 1.0. Var is calibrated for air when turned fully cw.
**Distance Cal Scales, Option 01 Only (Vρ/Vair)** — Selectable from 0.2 to 1.0 in 0.01 increments.
**Sweep Repetition** — 40 Hz within +0 Hz, −10 Hz with Noise Filter Switch "Out." 20 s/sweep nominal in chart recorder mode (dependent upon chart recorder). 4 Hz within ±20% with Noise Filter Switch "In."

#### UNIQUE CHARACTERISTICS (1503 OPTION 05)

#### TEST SIGNAL

**Duration*1** — ≤3 m (10 ns), ≤30 m (100 ns), ≤300 m (1000 ns).
**Jitter** — ≤0.2 m for X1 (≤2 ns). ≤2 m for X10 (≤20 ns).
*1 *Duration times are within ±20% at half amplitude.*

#### HORIZONTAL SYSTEM

**Distance Controls**
**Distance Dial** — Range: 0 m to 500 m at X1. 0 m to 5,000 m at X10. Accuracy: Within 2% of reading ±0.2 m for X1. Within 2% of reading ±2 m for X10.
**Meters/Div Control** — Range: 1 m/div to 100 m/div at X1. 10 m/div to 1000 m/div at X10.

### COMMON CHARACTERISTICS (1502 & 1503)

#### POWER REQUIREMENTS

**Ac Power** — Line Voltage: 117 V ac ±20% and 234 V ac ±20%. Line Frequency: 48 Hz to 410 Hz.
**Dc Power**
Battery Pack Operation: At least 5 hours (+20°C to +25°C charge and discharge temperature) including 20 chart recordings.
**Full Charge Time** — 16 hours.
**Typical Charge Capacity**

| Charge Temperature | Discharge Temperature | | |
|---|---|---|---|
| | −15°C | +20°C to +25°C | +55°C |
| 0°C | 40% | 60% | 50% |
| +20°C to +25°C | 65% | 100% | 85% |
| +40°C | 40% | 65% | 55% |

#### EXTERNAL RECORDER INTERFACE (STANDARD X-Y MODULE)

**Horizontal** — 0.1 V/div, source impedance is 10 kΩ.
**Vertical** — 0.09 V/div to 0.13 V/div (adjustable), source impedance is 10 kΩ.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width (with handle) | 315 | 12.4 |
| Width (without handle) | 300 | 11.8 |
| Height | 127 | 5.0 |
| Depth (handle extended) | 475 | 18.7 |
| Depth (handle not extended) | 419 | 16.5 |
| **Weights** | **kg** | **lb** |
| Net (with front cover and accessories) | 8.2 | 18.0 |
| Net (without front cover or accessories) | 7.3 | 16.0 |
| Domestic Shipping (complete) ≈ | 11.1 | 24.4 |
| Export Shipping (complete) ≈ | 16.3 | 36.0 |

#### INCLUDED ACCESSORIES

Watertight front cover (200-1759-00); TDR slide rule for 1502 only (003-0700-00); 50 Ω BNC terminator (011-0123-00); precision 50 Ω cable for 1502 only (012-0482-00); viewing hood (016-0297-00); X-Y output module (016-0606-00); 110 V ac replacement fuses (for front panel) for 1502 only (159-0032-00) or 220 V ac (159-0029-01); power cord (161-0066-00); mesh filter (CRT) (378-0055-00); BNC female-to-female adaptor for 1502 only (103-0028-00); 9 ft BNC-to-clip-lead cable (012-0671-02); operator's manual.

### ORDERING INFORMATION

**1502** Short Range TDR Cable Tester . **$6,200**
**1503** Short Range TDR Cable Tester . **$5,200**
**Option 01** — (Distance Cal for 1503 only) ..... **+$375**
**Option 04** — With Cable Tester Recorder ..... **+$1,050**
**Option 05** — With Cable Tester Metric Version) ..... **NC**
**Option 76** — GM (P7) Phosphor ..... **+$35**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz

#### OPTIONAL ACCESSORIES (1502)

**Chart Recorder** — Order 016-0506-04 ..... **$1,100**
**Chart Paper** — One Roll. Order 006-1658-01 ..... **$7.50**
**Chart Paper** — 100 Roll Case. Order 006-1658-02 ..... **$550**
**Accessory Pouch** — Order 016-0351-00 ..... **$25**
**Static Suppressor** — (Helps protect front end from damage). Order 011-0132-00 ..... **$50**
**Impedance Adaptor** —
50/75 Ω. Order 017-0091-00*1 ..... **$150**
50/93 Ω. Order 017-0092-00*1 ..... **$150**
50/125 Ω. Order 017-0090-00*1 ..... **$150**
*1*Should be purchased with following two parts:*
**Connector, BNC Female-to-GR** — Order 017-0063-00 .. **$43**
**Connector, BNC Male-to-GR** — Order 017-0064-00 ..... **$75**

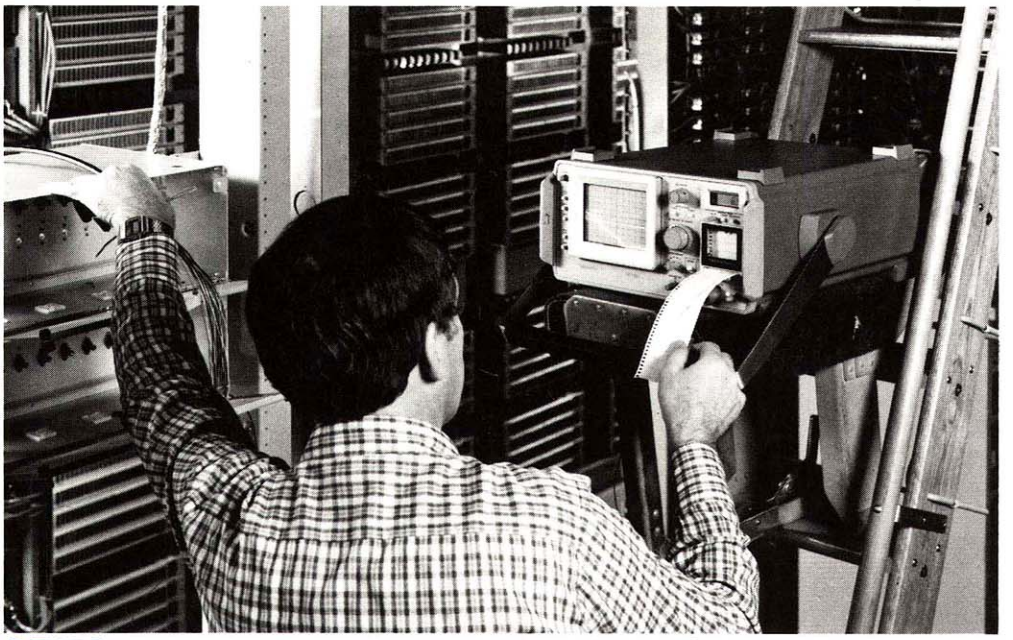
#### OPTIONAL ACCESSORIES (1503)

**Chart Recorder** — Order 016-0506-04 ..... **$1,100**
**Chart Paper** — One Roll. Order 006-1658-01 ..... **$7.50**
**Chart Paper** — 100 Roll Case. Order 006-1658-02 ..... **$550**
**Isolation Network** — (For balanced line). Order 013-0169-00 ..... **$225**
**Adaptor Cables (BNC-to-Clips)** —
Nine foot. Order 012-0671-02 ..... **$60**
30 foot. Order 012-0671-03 ..... **$70**
**Accessory Pouch** — Order 016-0351-00 ..... **$25**
**Direct Current Adaptor with Filter** — 25 foot cord (for use with standard 12 V automobile lighter plug with negative ground). Order 015-0327-00 ..... **$200**

### LOGISTICS INFORMATION

For logistics data, see Tektronix Logistics Data Book.

# FIBER OPTIC TDR CABLE TESTERS



## OF150 820 nm Fiber Optic TDR

**LCD Readout Resolution to 0.1 dB/1.0 Meter**

**Accurate, Repeatable Measurements**

**Built-In Chart Recorder, Optional Recorder Output**

**Digital Storage Provides Easy to View Waveform and Noise Reduction**

**Two Selectable Pulse Widths**

**Portable — Operates from 12 Volt Vehicle System or Battery Pack**

### Unmatched Range

The OF150 is a high performance, easy to use, portable instrument that can perform repeatable, accurate distance and loss measurements on multimode optical fibers.

Typical applications include: splice measurement through a one-way cable loss of up to 21.5 dB to within ±0.1 dB; detection of fiber ends, (four percent Fresnel reflection) through a one-way cable loss of up to 42.5 dB; and measuring distance to discontinuities (such as splices, Fiber faults and ends) to 19.9 km, with one meter resolution.

### Direct Readout Saves Time and Errors

The OF150 gives you direct LCD readout of results, eliminating voltage-to-power and time-to-distance computations and risk of operator errors. Direct readout assures accurate, repeatable measurements every time. A built-in chart recorder provides a permanent record of the waveform for reference and comparison.

### Get an Accurate Picture of Splice Loss

Digital storage produces a consistently sharp, easy-to-view trace. Signal averaging and selectable filters help maintain waveform resolution, so that measurements are made as accurately at long distances as closer in.

Two filters provide signal averaging and incremental decreases in the RMS noise floor. Compared to Fast filter operation (fast sweep), the Medium filter (medium sweep) provides a 7.5 dB reduction and the Slow filter (slow sweep) a 15 dB reduction. By using the Fast-Medium-Slow selection, you can pick the optimum signal acquisition speed/noise reduction combination.

The OF150 also offers two selectable pulse widths. The short pulse increases resolution for close-in measurements, while the long pulse extends distance/loss measurement range.

### Easy to Use

The OF150 combines high performance with ease of use. With Tektronix supplied manuals, craftspeople or technicians can learn to use this instrument in two hours or less.

### Portability and Convenience

Its compact size, light weight and rugged design, plus the ability to operate easily from a 12 volt vehicle system or external battery pack, enables the OF150 to offer exceptional portability in a high performance instrument.

## CHARACTERISTICS

### OPTICAL TEST SIGNAL

**Wavelength** — 820 nm (nominal).

**Displayed Pulse Width** — Long Pulse: 5.5 m, ±1 m. Short Pulse: 1.5 m, ±0.3 m.

**System Pulse Rate** — 4.762 kHz ±5 Hz.

**Optical Output Amplitude** — ≥25 μW Time-average power coupled into test fiber (50 μm core, 0.20 NA) (Long Pulse mode).

**Absolute Maximum Optical Output Amplitude** — 200 μW time averaged power.

**Displayed Pulse Risetime** — <0.7 m from −20 dB point to −6 dB point.

### MEASUREMENT RANGE

**Decrease in RMS Noise Floor through Filtering** — With Medium Filter: 0.75 div (7.5 dB). With Slow Filter: 1.5 div (15.0 dB).

**Optical Input Sensitivity** — ≤0.40 μW input for 30 dB above displayed RMS noise floor.

**Dynamic Range** — 105 dB (typical) between peak optical output pulse and RMS noise floor (Slow Filter).

**Maximum Round Trip Fiber Loss for Fiber End Detection** — 85 dB typical (assuming 4% Fresnel reflection).

**Maximum Round Trip Fiber Loss for ±0.1 dB Scattering Signal Measurements** — 43 dB typical (dependent on fiber characteristics).

### CRT VERTICAL DISPLAY

**Vertical Scales** — 10 dB/div and 2 dB/div (10 div).

**dB Scale Accuracy** — ±0.5 dB over any 10 dB increment from +20 dB to +70 dB, relative to bottom of display range.

### CRT HORIZONTAL DISPLAY

**Distance Scales** — 1 m/div to 1000 m/div.

**Display Limits** — −5 m to 19.9 km from front-panel connector.

**Sweep Time** — Fast: 0.15 s. Med: 3.15 s. Slow: 55 s.

**On-screen Distance Calibration** — 5.00 ns/m.

**"Zero" Distance Reference Accuracy** — ±0.5 m on screen.

### LCD NUMERIC READOUT

**Distance** — Readout Range: 0 km to 19.9 km.

**Distance Readout Resolution** — 1 m.

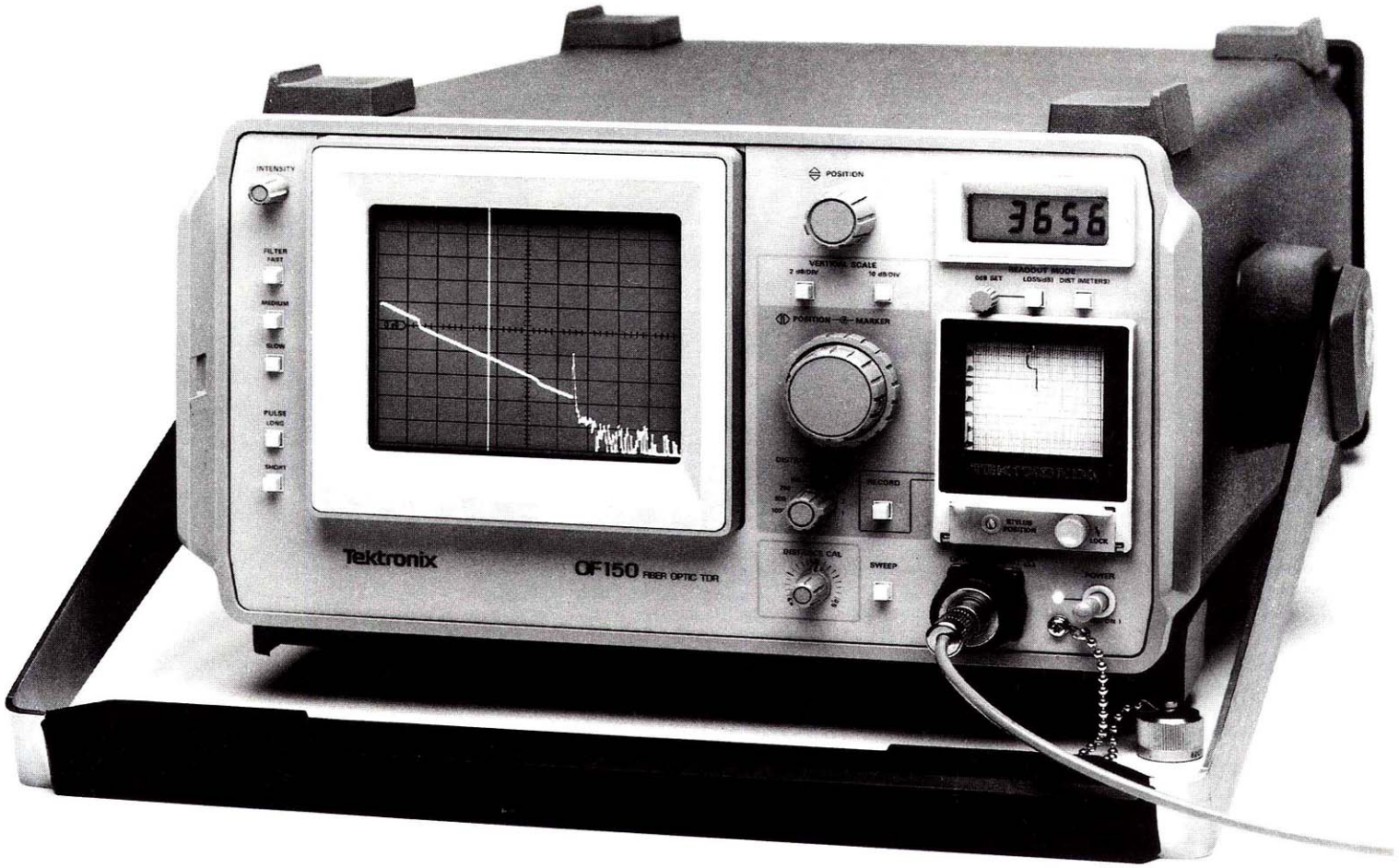
**Distance Cal Factor Range** — 4.9 ns/m to 5.1 ns/m.

**Distance Cal Factor Accuracy** — Within 0.01 ns/m of panel indication at center of scale (5,000); within 0.02 ns/m of panel indication at scale end points.

**Loss Measurements** — Readout Range: −25 dB to +25 dB (one way fiber loss) from center reference point. Readout Resolution: 2 dB/div scale: 0.1 dB; 10 dB/div scale: 0.5 dB.

**Distance Measurement Accuracy** — ±0.3%*1 ±uncertainty in Fiber Cal Factor.

*1 *Instrument timing in accuracy plus distance cal factor indication error.*




### SAFETY

Meets Class I Laser product safety classification under Radiation Control for Health and Safety Act of 1968. Optical output connector interlock prevents optical output when interlock is open.

### ENVIRONMENTAL CHARACTERISTICS

The OF150 meets the specifications of MIL-T-28800B, Type III, Class 3, Style C except for Radiated Emission specification RE-01.

**Altitude** — Operating: 4600 m (15,500 ft). Nonoperating: 12 000 m (40,000 ft).

**Temperature** — Operating: −15°C to +55°C. Nonoperating: −62°C to +85°C.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width (Without front cover, handle or feet) | 327 | 13.1 |
| Height | 175 | 7.0 |
| Depth | 499 | 20.0 |
| **Weight** | **kg** | **lb** |
| Net (Includes accessories except manual) | 16.6 | 37.0 |

### POWER REQUIREMENTS

**Ac Operation** — 90 V ac to 132 V ac, 45 Hz to 440 Hz, 180 V ac to 250 V ac, 45 Hz to 440 Hz 24 W nominal (55 W maximum).

**Dc Operation** — 10 V dc to 16 V dc 20 W nominal (33 W maximum).

The above specifications are for the standard instrument. Specifications may vary for Option 20.

### INCLUDED ACCESSORIES

Optical fiber interface cable, battery power cord (161-0149-00); ac power cord (161-0118-00); interlock contact ring replacement lens assembly (131-2741-02); protective cover for fiber optic interface cable, cable retainer (343-0170-00); ac power cord (161-0149-00); operator's manual.

## XY1 OUTPUT MODULE (OPTION 01)

The XY1 provides signals which correspond to the trace on the CRT and can be used to drive an external analog plotter or chart recorder.

### ELECTRICAL SPECIFICATIONS XY1 OUTPUT MODULE

**X (Horizontal) Scale** — 0.1 ±5% per major division on CRT.

**X Gain** — Sets X-axis full scale between 0.5 V to 1.2 V.

**Y (Vertical) Scale** — 0.1 V ±5% of signal per major division on CRT.

**Y Offset** — Sets Y-axis mid-scale between 0.1 V and 0.9 V.

**Z Output (Pen Lift)** — TTL compatible, nominal +5 V. Logic output internally selectable.

**Sweep Time** — 14 s ±1 s.

### CHART RECORDER (OPTION 04)

**Chart Dimensions** — 40 mm x 125 mm (corresponding to the full CRT graticule area).

**Chart Distance Scale Linearity** — ±0.2 major division match at any point.

**Chart Vertical Scale Linearity** — ±5% of deflection from center, ±0.3 major division.

**Chart Running Time** — 16 s.

## ORDERING INFORMATION

**OF150** Fiber Optic Time Domain Reflectometer ..... **$17,500**

**Option 01** — XY1 Output Module ..... **+$300**
**Option 04** — Chart Recorder ..... **+$1,050**
**Option 05** — 850 nm Wavelength (nominal) ..... **NC**
**Option 20** — Western Electric Connector ..... **NC**

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

### OPTIONAL ACCESSORIES

**Camera** — C-5C ..... **$495**
**Hard Case** — Transit. Order 016-0658-00 ..... **$625**
**Soft Case** — Order 016-0659-00 ..... **$125**
**Receptacle Connector Optical** — Ten each. Order 013-0207-02 ..... **$375**
**Chart Paper** — One Roll. Order 006-3618-00 ..... **$9.25**
**Chart Paper** — 25 Rolls. Order 006-3618-01 ..... **$210**
**Chart Paper** — 100 rolls. Order 006-3618-02 ..... **$695**
**Accessory Kit** — Deutsch Tools and Plugs. Order 015-0474-00 ..... **$695**
**Sun Visor** — Order 016-0653-00 ..... **$30**
**XY1 Output Module** ..... **$350**
**Chart Recorder** — Order 016-0506-05 ..... **$1,100**
**Service Manual.**

NEW

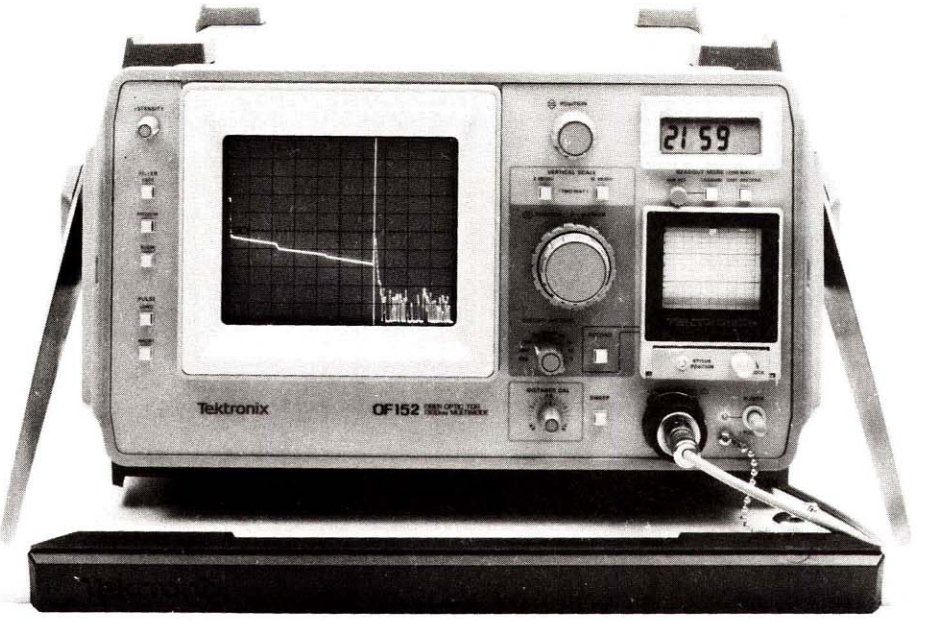
## OF152 1300 nm Fiber Optic TDR

**LCD Readout**

**Accurate, Repeatable Measurements**

**Built-In Chart Recorder**

**Portable — Operates from 12 Volt Vehicle System or Battery Pack**




The rugged, easy-to-use Tektronix OF152 Fiber Optic TDR makes quantitative, calibrated loss and distance measurements on multimode fiber at the 1300 nm wavelength. The instrument typically measures breaks through 35 dB, and splices to ±0.1 dB through 13.5 dB of one way cable loss depending on fiber characteristics. Maximum readout range is 60 km, with finely detailed resolution to one meter.

The OF152 OTDR allows fast and accurate loss measurement, providing an instant, at-a-glance view of the fiber length on the built-in CRT screen.

The OF152 is portable, with a single handle for carrying ease. It operates at virtually any altitude or temperature, from a 12 V vehicle system, an external battery pack or ac. No regulated power source is required.

Like the Tektronix 820 nm OF150 OTDR, the OF152 meets the rigorous specifications of MIL-T28800C, Type III, Class 3, Style C (except for Radiated Emission Specification RE-01).

The OF152 is backed by a worldwide network of Tektronix support and service. A range of options, including a chart recorder, is available.

### CHARACTERISTICS

#### OPTICAL TEST SIGNAL

**Wavelength** — 1300 nm (typical).

**Displayed Pulse Width** — Long Pulse: 110 m, ±6 m. Short Pulse: 20 m, ±1.2 m.

**System Pulse Rate** — 1.550 kHz ±1.5 Hz.

**Optical Output Amplitude** — ⩾19 μW Time-average power coupled into test fiber (50 μm core, 0.20 NA) (Long Pulse mode).

**Absolute Maximum Optical Output Amplitude** — 50 μW time average.

**Displayed Pulse Risetime** — <10 m from −20 dB point to −6 dB point.

#### MEASUREMENT RANGE

**Decrease in RMS Noise Floor Through Filtering** — Medium Filter: 7.5 dB nominal. Slow Filter: 15 dB nominal.

**Optical Input Sensitivity** — ⩽1.5 μW input for 30 dB above displayed RMS noise floor.

**Dynamic Range** — 84 dB minimum between peak optical output pulse and RMS noise floor (Slow Filter).

**Maximum Round Trip Fiber Loss for Fiber End Detection** — 70 dB typical (assuming 4% Fresnel reflection) (slow filter).

**Maximum Round Trip Range for Backscatter Signal with SNR=1** — 42 dB typical (dependent on fiber backscatter coefficient).

**Maximum Round Trip Fiber Loss for ±0.1 dB Scattering Signal Measurements** — 27 dB typical (dependent on fiber characteristics).

#### CRT VERTICAL DISPLAY

**Vertical Scales** — 10 dB div and 2 dB div (10 div).

**dB Scale Accuracy** — ±0.5 dB over any 10 dB div increment from +20 dB to +60 dB, relative to bottom of display range.

#### CRT HORIZONTAL DISPLAY

**Distance Scales** — 5 m/div to 5000 m/div.

**Display Limits** — −25 m to 60 km from front-panel connector.

**Sweep Time** — Fast: 0.33 s. Medium: 11 s. Slow: 180 s.

**On-Screen Distance Calibration** — 5.00 ns/m.

**"Zero" Distance Reference Accuracy** — ±2.0 m.

#### LCD NUMERIC READOUT

**Distance** — Readout Range: 0 km to 60.0 km. Readout Resolution: 1 m. Cal Factor Range: 4.9 ns/m to 5.1 ns/m. Cal Factor Accuracy: Within 0.01 ns/m of panel indication at center of scale (5.000). Within 0.02 ns/m of panel indication at scale end points.

**Measurement Accuracy** — ±0.3%*1 ± the uncertainty in fiber cal factor.

**Loss Measurements** — Readout Range: −25.0 dB to +25.0 dB (one way fiber loss) from center reference point. Readout Resolution: 0.05 dB (2 dB/div scale); 0.25 dB (10 dB/div scale).

**1 Instrument timing plus DISTANCE CAL factor indication error.*

#### SAFETY

Meets Class I Laser product safety classification under Radiation Control for Health and Safety Act of 1968. Optical output connector interlock prevents optical output when interlock is open.

#### POWER REQUIREMENTS

**Ac Operation** — 90 V ac to 132 V ac, 45 Hz to 440 Hz, 180 V ac to 250 V ac, 45 Hz to 440 Hz, 24 W nominal (55 W maximum).

**Dc Operation** — 10 V dc to 16 V dc, 20 W nominal (33 W maximum).

*The above specifications are for the standard instrument. Specifications may vary for Option 20.*

#### ENVIRONMENTAL CHARACTERISTICS

The OF152 meets the specifications of MIL-T-28800C, Type III, Class 3, Style C except for Radiated Emission specification RE-01.

**Altitude** — Operating: 4600 m (15,000 ft). Nonoperating: 12 000 m (40,000 ft).

**Temperature** — Operating: −15°C to +55°C. Nonoperating: −62°C to +85°C.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width (Without front cover, handle or feet) | 327 | 13.1 |
| Height | 175 | 7.0 |
| Depth | 499 | 20.0 |
| **Weight** | **kg** | **lb** |
| Net (Includes accessories) | 16.3 | 36.0 |

#### INCLUDED ACCESSORIES

Blank module (016-0782-00); ac power cord (161-0104-00); battery power cord (161-0149-00); interlock contact ring (352-0654-01); optical fiber interface cable (175-4572-00); spare connector, receptacle, optical (standard instrument only) (131-2741-02); spare fuse (159-0032-00); operator's handbook.

### ORDERING INFORMATION

**OF152** Fiber Optic Time Domain Reflectometer ..... **$19,500**

**Option 01** — XY1 Output Module ..... **$300**

**Option 04** — Chart Recorder ..... **$1,050**

**Option 20** — Western Electric Connector ..... **NC**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

#### OPTIONAL ACCESSORIES

**Camera** — C-5C ..... **$495**
**Hard Case** — Transit. Order 016-0658-00 ..... **$625**
**Soft Case** — Order 016-0659-00 ..... **$125**
**Optical Connector Receptacle** — Ten each. Order 013-207-02 ..... **$375**
**Chart Paper** — Roll. Order 006-3618-00 ..... **$9.25**
**Chart Paper** — 25 rolls. Order 006-3618-01 ..... **$210**
**Chart Paper** — 100 rolls. Order 006-3618-02 ..... **$695**
**Accessory Kit** — Deutsch Tool and Plugs. Order 015-0474-00 ..... **$695**
**Sun Visor** — Order 016-0653-00 ..... **$30**
**XY1 Output Module** — ..... **$350**
**Chart Recorder** — Order 016-0506-05 ..... **$1,100**

# SPECTRUM ANALYZERS & SWEPT FREQUENCY SYSTEMS

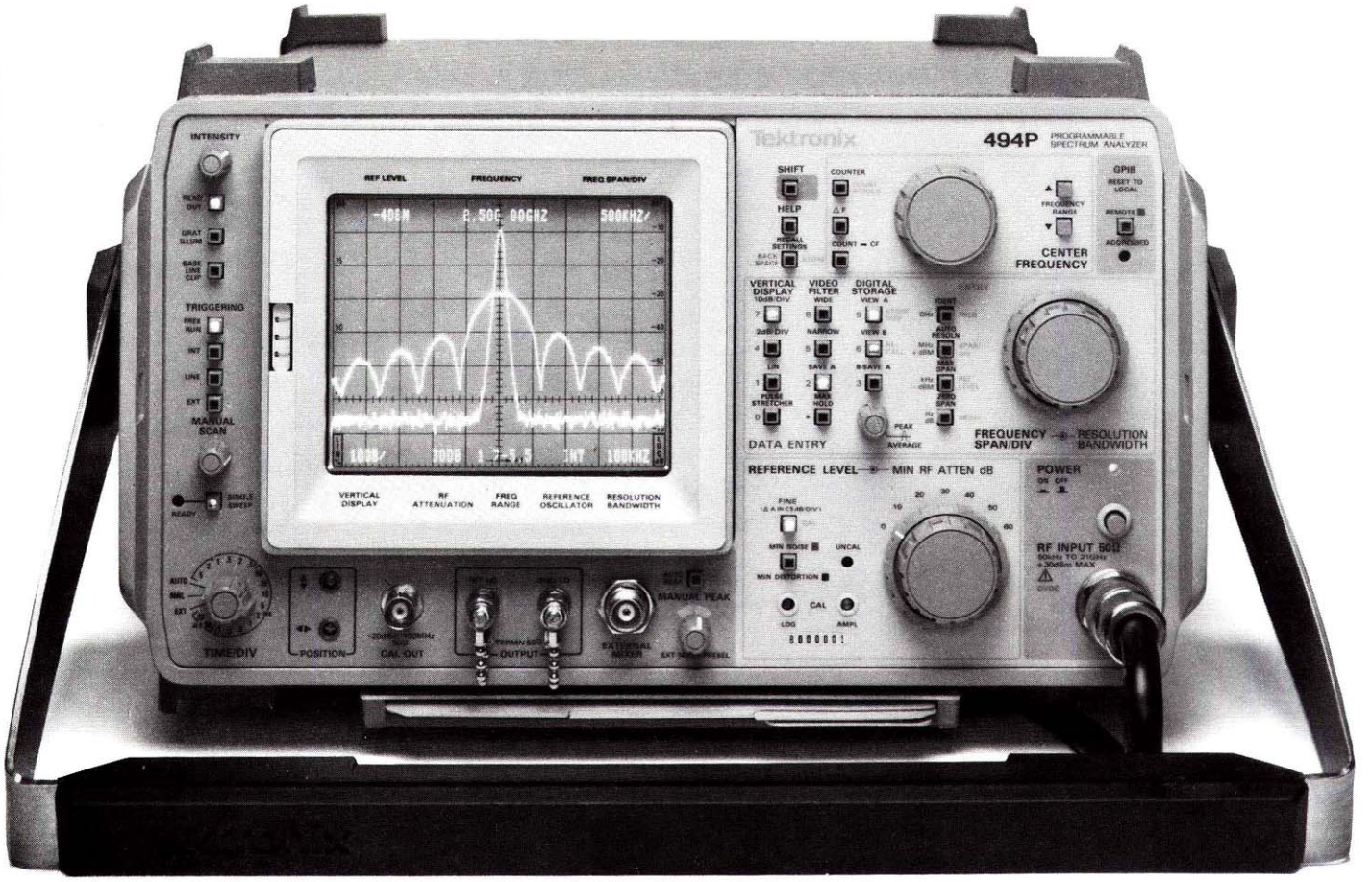
**Choose among a large selection of capabilities: Top RF performance, portability and full programmability in the 490 Series; versatility and high performance economy in the 7000 Series plug-ins—from baseband through millimeter-wave.**

**PRODUCT SELECTION GUIDE**

| Model | Frequency Range | Minimum Resolution | Average Noise Level (1 kHz BW) | Amplitude Measurement Range | GPIB Capability | Tracking Generator | Frequency Accuracy | Page |
|---|---|---|---|---|---|---|---|---|
| **7L5** | 20 Hz to 5 MHz | 10 Hz | −133 dBV | +8 dBV to −148 dBV | Semiauto w/7854 | Option 25 | ±(5 Hz + 2 x $10^{-6}$ Dot Freq) | 212 |
| **7L12** | 100 kHz to 1.8 GHz | 300 Hz | −113 dBm | +30 dBm to −115 dBm | Semiauto w/7854 | TR 502 | ±(8 MHz +1% of Dial) | 211 |
| **7L14** | 10 kHz to 1.8 GHz | 30 Hz | −115 dBm | +30 dBm to −130 dBm | Semiauto w/7854 | TR 502 | ±(5 MHz + 20% Span) | 210 |
| **496** | 1 kHz to 1.8 GHz | 30 Hz | −115 dBm | +30 dBm to −126 dBm | | TR 503 | ±(5 MHz + 20% Span) | 205 |
| **496P** | 1 kHz to 1.8 GHz | 30 Hz | −115 dBm | +30 dBm to −126 dBm | Full | TR 503 | ±(5 MHz + 20% Span) | 205 |
| **7L12 Option 39** | 100 kHz to 2.5 GHz | 300 Hz | −113 dBm | +30 dBm to −115 dBm | Semi Auto W/7854 | TR 502 (To 1.8 GHz) | ±(8 MHz +1% of Dial) | 211 |
| **7L14 Option 39** | 1 kHz to 2.5 GHz | 30 Hz | −115 dBm | +30 dBm to −130 dBm | Semi Auto W/7854 | TR 502 (To 1.8 GHz) | ±(5 MHz +20% Span) | 210 |
| **492** | 50 kHz to 220 GHz | 100 Hz | −110 dBm | +30 dBm to −118 dBm | | TR 503 | ±(0.2% or 5 MHz + 20% Span) | 207 |
| **492P** | 50 kHz to 220 GHz | 100 Hz | −110 dBm | +30 dBm to −118 dBm | Full | TR 503 | ±(0.2% or 5 MHz + 20% Span) | 207 |
| **494** | 10 kHz to 325 GHz | 30 Hz | −110 dBm | +30 dBm to −121 dBm | | TR 503 | ±[(20% Span or RES BW) +(CF X REF error) + (2N + 25 Hz)] | 202 |
| **494P** | 10 kHz to 325 GHz | 30 Hz | −110 dBm | +30 dBm to −121 dBm | Full | TR 503 | ±[(20% Span or RES BW) +(CF X REF error) + (2N + 25 Hz)] | 202 |

**Waveguide Mixers, See Page 209**
**Tracking Generators See Page 214**
**Accessories See Page 216**

# TEK 10 kHz TO 325 GHz PORTABLE SPECTRUM ANALYZER




GPIB IEEE-488 **494P** **494**

The 494P complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

- **Built-In Frequency Counter to 325 GHz**
- **HELP Manual in ROM**
- **Nonvolatile Memory Storage**
- **Keypad Data Entry**
- **Direct Plot Capability**
- **Alternate Language Options**
- **Full Three Year Warranty**

**More accuracy, convenience, performance, and value**

The new Tek 494 and fully programmable 494P are altogether advanced, innovative spectrum analyzers offering portability, ease of use and unprecedented versatility. They deliver maximum utility and benefits at a surprisingly reasonable cost.

**Counter center frequency accuracy, zero long-term drift, superior range and resolution in a compact, portable package**

The 494 offers the widest amplitude calibrated frequency range of any spectrum analyzer available: 10 kHz to 21 GHz in coax, and 325 GHz using one or more of ten Tek waveguide mixers.

A 4 GHz signal can be measured to within 41 Hz with 1 Hz readout resolution 30 minutes after turn on. And the 494's zero drift will insure long-term measurement repeatability on that frequency.

You get 30 Hz resolution bandwidth to 60 GHz, 100 Hz resolution bandwidth to 220 GHz and 1 kHz bandwidth to 325 GHz with excellent sensitivity and low phase noise. Popular features common to other 490 Series spectrum analyzers are standard on the 494, including digital storage, manual to programmable convertibility, and environmentalization per MIL-T-28800C, Type III, Class 3, Style C.

An exclusive pushbutton *HELP* mode makes the 494 accessible to operators of widely varying skills and experience. At the touch of a button or twist of a knob the 494 tells you what to expect from nearly every control—in plain English. Plus optional French, German, or Spanish. Pull-out reference cards supply an additional level of detail. Having answers available at your fingertips minimizes training time and reduces complexity.

**Center frequency, span/div., amplitude scaling and reference level selected either by μP-aided three-knob operation or direct pushbutton entry**

In push-button mode, variables can be set to non-standard values, i.e., 7 dB/div vertical mode or 9.2 kHz/div frequency span.

Nonvolatile memory retains up to ten set-ups and nine displays—for rapid measurements and easy data comparison. One memory location stores on-screen settings to quickly bring the analyzer back if power is turned off.

The fully programmable 494P provides easy-to-implement automated measurements. The 494P is straightforward to interface to our GPIB controllers...or yours. If you want to free your controller but still get graphics output, a convenient front panel *PLOT* button will send display data to a plotter.

In strong testimony of the incomparable reliability of the 494 and 494P, Tek offers the first spectrum analyzer three year warranty. Beyond the first three years of warranty coverage, Tek will extend your service coverage for two years providing all your calibration and maintenance needs for the first five years.

NEW

## CHARACTERISTICS

The following characteristics and features apply to the 494/494P Spectrum Analyzer after a 30-minute warmup period unless otherwise noted.

### FREQUENCY RELATED

**Center Frequency Range** — 10 kHz to 21 GHz standard; amplitude specified coverage to 325 GHz with optional Tektronix waveguide WM 490 Series mixers.

**Center Frequency Accuracy** — Bands 1 and 5-12 with span/div >200 kHz and bands 2-4 with span/div >100 kHz.

±[(20% of span/div or res bw, whichever is greatest) + (CF x Ref Freq Error) + (N x 15 kHz)].

Bands 1 and 5-12 with span/div ≤200 kHz and Bands 2-4 with span/div ≤100 kHz.

±[(20% of span/div or res bw, whichever is greater) + (CF x Ref Freq Error) + (2N + 25 Hz)].

**Center Frequency, Readout Resolution** — At least 10% of span/div.

**Signal Counter Accuracy** — ±[(Counter Frequency x Reference Frequency error) + (10 + 2N) Hz + 1 LSD)].

**Counter Sensitivity** — Center Screen S/N ≥20 dB.

**Counter Frequency Readout Resolution** — 1 Hz through 1 GHz.

**Reference Frequency Error (Aging Rate)** — 1 x $10^{-9}$/day, 1 x $10^{-7}$/year.

**Frequency Span Per Division** — 50 Hz/div to 500 MHz/div in coaxial bands (10 kHz through 21 GHz) and 50 Hz/div to 10 GHz/div in waveguide bands (18 GHz through 325 GHz), plus zero span and maximum span. Any span to two significant digits (within 50 Hz and up to 10 GHz) can also be selected with the Data Entry Keyboard.

**Frequency Span/Div Accuracy** — Within 5% of the selected span/div over the center 8 div of the 10 div CRT display.

**Resolution Bandwidth (6 dB)** — 30 Hz then 100 Hz to 1 MHz in decade steps plus auto.

**Accuracy** — Within 20%.

**Shape Factor (60 dB/6 dB)** — 7.5:1 or less, 100 Hz through 1 MHz and 15:1 or less for 30 Hz.

**Residual FM (After 1 Hour Warmup)** — Bands 1 and 5-12 with span/div >200 kHz, and bands 2-4 with span/div >100 kHz: ≤(7 kHz) N total excursion in 20 ms.

Bands 1 and 5-12 with span/div ≤200 kHz, and bands 2-4 with span/div ≤100 kHz: ≤(10 + 2N) Hz total excursion in 20 ms.

**Long-Term Drift (at Constant Temperature and Fixed Center Frequency and After 1 Hour Warmup)** — Bands 1 and 5-12 with span/div >200 kHz, and bands 2-4 with span/div >100 kHz: ≤(5 kHz) N per minute of sweep time.

Bands 1 and 5-12 with span/div ≤200 kHz, and Bands 2-4 with span/div ≤100 kHz: ≤50 Hz per minute of sweep time.

**Noise Sidebands** — At least −75 dBc at 30 times the resolution bandwidth offset from the center frequency (−70 dBc for 100 Hz resolution bandwidth or less).

### AMPLITUDE RELATED

**Reference Level Range** — Full screen, top of graticule −117 dBm to + 40 dBm (+40 dBm, includes maximum safe input of +30 dBm and 10 dB gain of IF gain reduction) for 10 dB/div and 2 dB/div log modes. 1 W maximum safe input in the linear mode.

**Vertical Display Modes** — 10 dB/div, 2 dB/div, and linear. Any integer between 1-15 dB/div can also be selected with the data entry keyboard.

**Reference Level Steps** — 10 dB, 1 dB and 0.25 dB for relative level (Δ) measurements in Log mode. 1-2-5 sequence and 1 dB equivalent increments in Lin mode. The RF attenuator steps 10 dB for reference level changes above −30 dBm (−20 dBm when minimum noise is active) unless minimum RF attenuation is greater than normal. The IF gain increases 10 dB for each reference level change below −30 dBm (−20 dBm when minimum noise is active).

**Display Dynamic Range** — 80 dB at 10 dB/div, 16 dB at 2 dB/div and 8 div in linear mode.

**Reference Level Accuracy** — Accuracy is a function of the characteristics listed below.

**Calibrator** — (Cal out) See output signal characteristics on next page.

**Input Attenuator Accuracy** — 0.3 dB/10 dB to a maximum of 0.7 dB over the 60 dB range, up to 4 GHz; 0.5 dB/10 dB to a maximum of 1.4 dB over the 60 dB range from 4 GHz to 18 GHz. 1.5 dB/10 dB to a maximum of 2.6 dB over the 60 dB range from 18 GHz to 21 GHz.

**Frequency Response** — See Frequency Response Table on this page.

## SENSITIVITY AND FREQUENCY RESPONSE

| Freq Range | LO Harmonic Number | Ave Noise Level For 1 kHz Res BW | Minimum Frequency Counter Sensitivity 30 Hz Res BW | | Freq Response Referenced To 100 MHz With 10 dB Attn | Freq Response About the Mid Point Between Two Extremes |
|---|---|---|---|---|---|---|
| 10 kHz-1.8 GHz | 1 | −110 dBm | −101 dBm | | ±3.0 dB | ±2.0 dB |
| 50 kHz-1.8 GHz | 1 | −110 dBm | −101 dBm | | ±2.5 dB | ±1.5 dB |
| 1.7 GHz-5.5 GHz | 1 | −110 dBm | −101 dBm | | ±3.5 dB | ±2.5 dB |
| 3.0 GHz-7.1 GHz | 1 | −110 dBm | −101 dBm | | ±3.5 dB | ±2.5 dB |
| 5.4 GHz-18.0 GHz | 3 | −95 dBm (to 12 GHz) −90 dBm (12-18 GHz) | −86 dBm −81 dBm | | ±4.5 dB | ±3.5 dB |
| 15.0 GHz-21.0 GHz | 3 | −85 dBm | −76 dBm | | ±6.5 dB | ±5.0 dB |
| **WITH TEKTRONIX OPTIONAL HIGH PERFORMANCE WAVEGUIDE MIXERS** | | | | | | |
| 18.0 GHz-26.5 GHz | 6 | −100 dBm | −91 dBm | WM 490K | ±6.0 dB | ±2.0 dB |
| 26.5 GHz-40 GHz | 10 | −95 dBm | −86 dBm | WM 490A | ±6.0 dB | ±2.0 dB |
| 33 GHz-50 GHz | 10 | −95 dBm | −86 dBm | WM 490Q | ±6.0 dB | ±2.0 dB |
| 40 GHz-60 GHz | 10 | −95 dBm | −86 dBm | WM 490U | ±6.0 dB | ±2.5 dB |
| *50 GHz-75 GHz | 15 | −95 dBm @ 50 GHz −90 dBm @ 75 GHz | −86 dBm −81 dBm | WM 490V | ±6.0 dB | ±3.0 dB |
| *60 GHz-90 GHz | 15 | −95 dBm @ 60 GHz −85 dBm @ 90 GHz | −89 dBm −79 dBm | WM 490E | ±6.0 dB | ±3.0 dB |
| *75 GHz-110 GHz | 23 | −90 dBm @ 75 GHz −80 dBm @ 110 GHz | −84 dBm −74 dBm | WM 490W | ±6.0 dB | ±3.0 dB |
| *90 GHz-140 GHz | 23 | −85 dBm @ 90 GHz −75 dBm @ 140 GHz | −79 dBm −69 dBm | WM 490F | ±6.0 dB | ±3.0 dB |
| *110 GHz-170 GHz | 37 | −80 dBm @ 110 GHz −70 dBm @ 170 GHz | −74 dBm −64 dBm | WM 490D | ±6.0 dB | ±3.0 dB |
| *140 GHz-220 GHz | 37 | −75 dBm @ 140 GHz −65 dBm @ 220 GHz | −69 dBm −59 dBm | WM 490G | ±6.0 dB | ±3.0 dB |
| *220 GHz-325 GHz | 56 | −65 dBm @220 GHZ −50 dBm @ 325 GHz | −50 dBm −35 dBm | 119-1728-00 J | ±6.0 dB | ±3.0 dB |

*Typical values and with frequency response indicated over any 5 GHz range.*

**Display Amplitude Accuracy** — ±1.0 dB/10 dB to a maximum cumulative error of ±2.0 dB over the 80 dB window and ±0.4 dB/2 dB to a maximum cumulative error of ±1.0 dB over the 16 dB window. Lin Mode is 5% of full scale.

**Resolution Bandwidth Gain Variation** — ±0.4 dB, after Cal routine has been executed and with respect to the 1 MHz filter.

**IF Gain Variation** — Gain steps are monotonic (same direction) with the following limits: Within 0.2 dB/dB to a maximum of 0.5 dB/9 dB, except at the decade transitions of −19 dBm to −20 dBm, −29 dBm to −30 dBm, −39 dBm to −40 dBm, −49 dBm to −50 dBm, and −59 dBm to −60 dBm, where an additional 0.5 dB can occur for a total of 1.0 dB per decade. Maximum deviation over the 97 dB range is within ±2 dB.

### SPURIOUS RESPONSES

**Residual (No Input Signal Referenced to Mixer Input)** — −100 dBm or less. Fundamental mixing Bands 1-3.

**Harmonic Distortion (cw Signal Minimum Distortion Mode)** — Typically −60 dBc for full screen signal in the minimum distortion mode to 21 GHz. At least −100 dBc for preselected bands 1.7 GHz to 21 GHz.

**Third-Order Intermodulation Distortion (Minimum Distortion Mode)** — At least 70 dB down from two full screen signals within any frequency span. At least 100 dB down for two signals spaced more than 100 MHz apart from 1.7 GHz to 21 GHz for preselected bands.

**LO Emissions (No RF Attenuation)** — −70 dBm maximum to 21 GHz.

### INPUT SIGNAL CHARACTERISTICS

**RF Input** — Type N female connector.
**Input Impedance** — 50 Ω.
**Maximum VSWR*[1] with ≥10 dB Attenuation**

| Frequency Range | Typical | Specified Maximum |
|---|---|---|
| Dc to 2.5 GHz | 1.2:1 | 1.3:1 |
| 2.5 GHz to 6.0 GHz | 1.5:1 | 1.7:1 |
| 6.0 GHz to 18 GHz | 1.9:1 | 2.3:1 |
| 18 GHz to 21 GHz | 2.7:1 | 3.5:1 |

*[1] At Type N female connector to internal mixer*

**Input Level (Optimum Mixer Level for Minimum Distortion Linear Operation)** — −30 dBm (minimum distortion control setting); 1 dB gain compression −23 dBm.

**Optimum Mixer Level for Minimum Noise Display Dynamic Range Enhanced Operation** — −20 dBm (minimum noise control setting); 1 dB gain compression −18 dBm.

**External Reference Frequency** — 1 MHz, 2 MHz, 5 MHz or 10 MHz ±5 ppm (minimum).

Waveshape: Sinewave, ECL, TTL duty cycle 40%-60%.

Input Impedance: 50 Ω ac, 500 Ω dc.

Power: −15 dBm to +15 dBm.

**Maximum Safe Input Level (RF Attenuation at Zero dB)** — +30 dBm (1 W) continuous, 75 W peak for 1 μs or less pulse width and 0.001 maximum duty factor (attenuation limit). Dc must never be applied to RF input.

NEW

SPECTRUM ANALYZERS

### OUTPUT SIGNAL CHARACTERISTICS

**Calibrator (Cal Out)** — −20 dBm ±0.3 dB, 100 MHz x reference frequency error.

**1st and 2nd LO** — Provides access to the output of the respective local oscillators (1st LO +7.5 dBm minimum to a maximum of +15 dBm; 2nd LO −22 dBm minimum to a maximum of +15 dBm). These ports must be terminated in 50 Ω at all times.

**Vertical Out** — Provides 0.5 V ±5% of signal/div of video above and below the center line.

**Horizontal Out** — Provides 0.5 V either side of center. Full range −2.5 V to +2.5 V ±10%.

**Pen Lift** — TTL, +5 V nominal to lift pen.

**IF Out** — Output of the 10 MHz IF. Level is approximately −5 dBm for a full screen signal at −30 dBm input reference level. Nominal impedance 50 Ω.

**Probe Power** — Provides operating voltages (+5 V, +15 V, −15 V, and ground) for active probes.

**494P Only: IEEE Standard 488-1978 Port (GPIB)** — In accordance with IEEE Standard 488.

### GENERAL CHARACTERISTICS

**Sweep Time** — 20 μs/div to 5 s/div in 1-2-5 sequence. (10 s/div in auto).

**CRT Readout** — Displays reference level, frequency, frequency span/div, vertical display, RF attenuation, resolution bandwidth, and reference oscillator.

**CRT** — 8 x 10 cm, GH (P31) Phosphor is standard.

**Configuration** — (Portable) 494/494P total weight including front cover and standard accessories 24 kg (52 lb), 17.5 cm x 32.7 cm x 49.9 cm (6.9 in x 12.9 in x 19.7 in) without handle or cover.

**Input Voltage** — 90 V ac to 132 V ac or 180 V ac to 250 V ac, 48 Hz to 440 Hz.

**Power** — 210 W maximum, 3.2 A, at 115 V and 60 Hz.

### ENVIRONMENTAL CHARACTERISTICS

Per MIL-T-28800C Type III, Class 3, Style C.

**Temperature** — Operating: −15°C to +55°C. Nonoperating: −62°C to +85°C.

**Humidity** — Operating: 95%. Nonoperating: 120 hours per MIL-STD-810.

**Rain Resistance** — Drip proof at 16 liters/hour/square foot.

**Altitude** — Operating: 4500 m (15,000 ft). Nonoperating: 12 000 m (40,000 ft).

**Vibration** — 5 Hz to 55 Hz at 0.020 inch excursion.

**Shock** — 30 g of half sine 11 ms duration.

**Drop** — 12 inches.

**Electromagnetic Compatibility** — 490 Series spectrum analyzers meet the requirements of MIL-STD-461B, operating from 48 Hz to 440 Hz power sources, with the exceptions shown below.

**Conducted Emissions** — CE01: 1 kHz to 15 kHz only. CE03 (Narrowband): Full limits. CE03 (Broadband): 15 dB relaxation from 15 kHz to 50 kHz.

**Conducted Susceptibility** — CS01: Full limits. CS02: Full limits. CS06: Full limits.

**Radiated Emissions** — RE01: 10 dB relaxation for first 10 harmonics of power line frequency, and exceptioned from 30 kHz to 36 kHz. RE02: Full limits.

**Radiated Susceptibility** — RS01: Full limits. RS02-1: Full limits. RS02-2: To 5 A only. RS03: Up to 1 GHz only.

### INCLUDED ACCESSORIES

Diplexer assembly (015-0385-00); 6 ft N to N connector 50 Ω coaxial cable, (012-0114-00); N male to BNC female adaptor (103-0045-00); 18 in BNC to BNC connector, 50 Ω coaxial cable (012-0076-00); CRT mesh filter (378-0726-01); two 4 A fast blow fuse (159-0017-00); 115 V power cord (161-0118-00); cord clamp (343-0170-00); CRT visor (016-0653-00); gray CRT light filter (378-0115-02); amber CRT light filter (378-0115-01); blue CRT light filter (378-0115-00); operators manual; operators handbook; 494P also includes 2 m, double shielded GPIB cable (012-0630-03); programmers manual.

## 490 Series Spectrum Analyzers
## Rackmount/Benchmount Options

The following options denote mechanical configurations of the 490 Series. Option 30 is a rackmount configuration for the 490 Series with standard front panel input/outputs. Option 31 is a rackmount configuration with rear panel input/output capability. Option 32 adds side covers and trim to an Option 31, making it into a stackable bench top configuration.

The Option 30 and 31 Rackmount is a standard 19 inch rack width and comes with standard rackmount fittings. A spectrum analyzer accessories storage drawer is also included. Dimensions are 22.23 cm x 42.9 cm x 63.5 cm (8.75 in x 16.89 in x 25.0 in). Weight is 32.7 kg (72 lb); including the spectrum analyzer.

The Option 32 Benchmount is approximately the same size as the Rackmount but is dressed with side and top panels and carrying handles and feet. The Benchmount provides a convenient surface for stacking other instruments. Dimensions are 23.5 cm x 45.7 cm x 63.5 cm (9.25 in x 17.9 in x 25.0 in). Weight is 31.8 kg (70 lb); including the spectrum analyzer.

### ORDERING INFORMATION

**494** Spectrum Analyzer ..... **$41,770**

**494P** Spectrum Analyzer ..... **$45,950**

**494 to 494P Conversion** — Conversions are made by your nearest Tektronix Service Center.
Specify 040-1140-00 ..... **$5,300**

**Option 08** — Delete External Mixer Capability. Deletes internal switching front panel connector and external diplexer to connect and use external wavequide mixers. ..... **−$1,750**

**Option 12** — Help Mode Text, CRT prompts selectable between German and English. Pull-out reference cards in German ..... **+$200**

**Option 13** — Help Mode Text, CRT prompts selectable between French and English. Pull-out reference cards in French ..... **+$200**

**Option 14** — Help Mode Text, CRT prompts selectable between Spanish and English. Pull-out reference cards in Spanish ..... **+$200**

**Option 20** — General Purpose 12.4 GHz to 40 GHz Waveguide Mixer Set includes three mixers (12.4 GHz to 18 GHz, 18 GHz to 26.5 GHz, and 26.5 GHz to 40 GHz) and attaching hardware to extend the upper frequency ..... **+$900**

**Option 21** — High Performance 18 GHz to 40 GHz Waveguide Mixer Set includes two mixers (18 GHz to 26.5 GHz and 26.5 GHz to 40 GHz) and attaching hardware to extend the upper frequency ..... **+$2,525**

**Option 22** — High Performance 18 GHz to 60 GHz Waveguide Mixer Set includes three mixers (18 GHz to 26.5 GHz, 26.5 GHz to 40 GHz, and 40 GHz to 60 GHz) and attaching hardware to extend the upper frequency ..... **+$4,250**

**Option 30** — Rackmount. 19 inch rack width with front panel input/outputs ..... **+$790**

**Option 31** — Rackmount. 19 inch rack width with rear panel input/output capability ..... **+$840**

**Option 32** — Benchmount. Adds side and top panels, carrying handles and feet for a stackable bench top configuration ..... **+$940**

**Option 41** — Digital Radio. Provides wider bandwidth preselector, 30 Hz video filter with 100 kHz resolution bandwidth and 5 MHz span/div optimized for 6 GHz and 11 GHz D/R . **+$450**

**Option 42** — 110 MHz IF Output. Provides 5 MHz bandwidth at 6 dB points ..... **+$1,500**

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

### *WARRANTY-PLUS* SERVICE PLAN—REFER TO PAGE 15

**M1** — Provides two calibrations during the warranty period, one in year two (2) and one in year three (3).
494 ..... **+$695**
494P ..... **+$715**

**M2** — Remedial service coverage for years four (4) and five (5).
494 ..... **+$1,330**
494P ..... **+$1,350**

**M3** — Provides four calibrations, one each in years two (2), three (3), four (4), and five (5), plus remedial service coverage for years four (4) and five (5).
494 ..... **+$2,725**
494P ..... **+$2,785**

**M4** — Provides five calibrations during the warranty period, one in year one (1) and two each in years two (2) and year three (3). Certification is provided with each calibration.
494 ..... **+$1,590**
494P ..... **+$1,630**

**M5** — Provides nine calibrations, one in year one (1) and two each in years two (2) through year five (5). Certification is provided with each calibration. Remedial coverage is extended to cover years four (4) and five (5).
494 ..... **+$4,145**
494P ..... **+$4,240**

### OPTIONAL ACCESSORIES

**TR 503 Tracking Generator** — For more information on the TR 503 see page 214 ..... **$6,620**

**Microwave Comb Generator TM 500 Series Compatible** — Order 067-0885-00 ..... **$1,800**

**75 Ω to 50 Ω Minimum Loss Pad** — Order 011-0112-00 **$60**

**Dc Block BNC to BNC** — Order 015-0221-00 ..... **$85**

**FET Probe P6201 to 900 MHz** — Order 010-6201-01 **$1,210**

**1405 TV Sideband Adaptor (525/60 Markers)** — .... **$5,780**

**C-5C Camera** — ..... **$495**

**TV Trigger Synchronizer** — Order 015-0261-01 ..... **$395**

**Hard Case (Transit)** — Order 016-0658-00 ..... **$625**

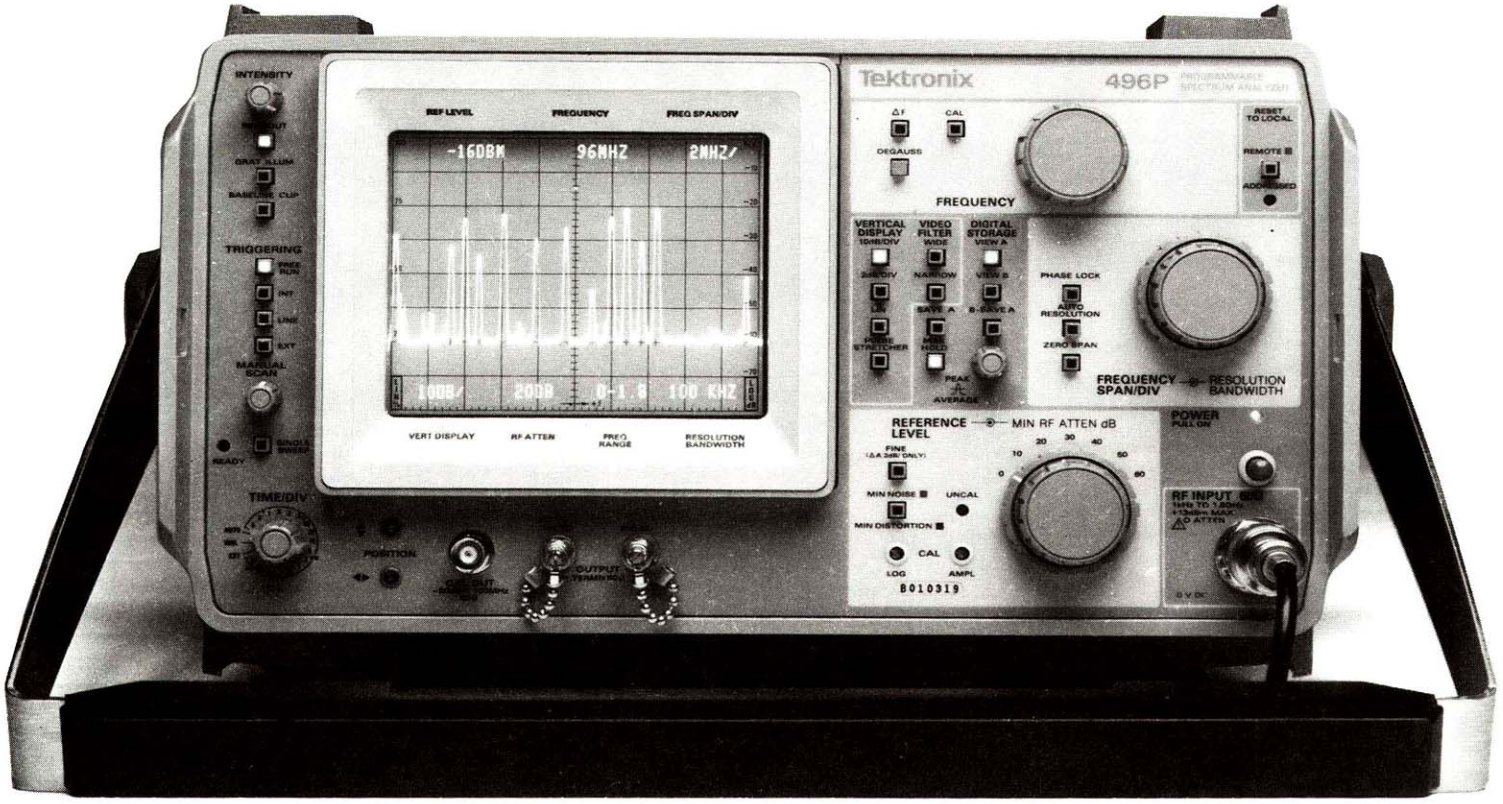
**Soft Case** — Order 016-0659-00 ..... **$125**

**Lab Cart Model 3** ..... **$595**

*Note: 490 Series spectrum analyzers are compatible with all Tektronix C-50 Series cameras.*

### PERIPHERAL PRODUCTS FOR 494P SPECTRUM ANALYZER

**4041** System Controller (See page 324) ..... **$3,995**
**4105** Color Terminal (See page 55) ..... **$3,995**
**4695** Color Graphics Copier (See page 68) ..... **$1,595**
**6120** Scientific Desktop Computer (See page 48) ..... **$7,995**




GPIB IEEE-488 **496P** **496**

The 496P complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**Microprocessor Aided Controls**

***NEW*** **50 Ω/75 Ω Selectable Inputs**

**Portable Form Factor (Compact Size/Light Weight)**

**1 kHz to 1800 MHz Coverage**

**Amplitude Comparison in 0.25 dB Steps**

**1 kHz Frequency Resolution in ΔF Mode**

**CRT Readout of all Important Parameters**

**Fully Calibrated Amplitude in dBm or dBmV**

**80 dB Dynamic Range**

**GPIB/Fully Programmable (496P)**

**Three-knob Operation**

**Environmentalized per MIL-T 28800C**

**Digital Storage and Signal Processing**

The 496 provides high performance spectrum analysis and measurements in the 1 kHz to 1.8 GHz range. Its high stability and 80 dB dynamic range meet your demands for proof-of-performance measurements, on site or on the bench.

The 496 offers state-of-the-art performance and rugged portability. Resolution bandwidth can be varied from 1 MHz to 30 Hz over the entire frequency range. Automatic phase lock stabilization reduces incidental FM to 10 Hz p-p; phase noise sidebands are at least −75 dBc at 30 times the resolution bandwidth offset. Frequency drift with phase lock is typically 1 kHz in 10 minutes after 30 minute warmup. And the 496 provides 1 kHz frequency resolution in ΔF mode.

**Easy to Use—Anywhere**

Simple 1, 2, 3 knob adjustment sets center frequency, frequency span and reference level. Power on sequence automatically normalizes operational settings and provides maximum input protection.

Digital storage eliminates time-consuming display adjustments. Save A, B Minus Save A, Max Hold and Average modes let you compare, subtract, save maximum values or noise average (smooth) your spectral displays. Constant tuning rate lets you position the signal quickly and accurately at any frequency span.

Microprocessor-aided controls take care of the rest. Most-used functions are automatically controlled.

**The 496 Goes Where You Go**

Lightweight and compact size combine to provide unmatched portability in a laboratory quality spectrum analyzer. With its single-handle carry, the 496 is easily moved around the design lab or systems test area, to the field, or wherever it may be needed. It even fits under an airplane seat.

***NEW*** **75 Ω Measurement Capability**

Option 07 offers two inputs and calibrations to select from. The standard 50 Ω input calibrated in dBm is accessed via the Type N connector. The 75 Ω input connector is bnc and provides calibrated dBmV measurement capability when activated. This option includes a 300 kHz resolution filter to enhance VHF/UHF measurements.

**Automate Your Spectrum Analysis with the 496P**

The 496P is the fully programmable/GPIB compatible version of the 496 Spectrum Analyzer. Operation, features and benefits of the 496P are essentially the same as the 492P. 496 Spectrum Analyzer specifications also apply to the 496P.

Manual instruments can be converted to programmable instruments at a later time. Contact your Tektronix Sales Engineer for details.

NEW

SPECTRUM ANALYZERS

## CHARACTERISTICS

The following characteristics and features apply to the 496/496P Spectrum Analyzers after a 30 minute warmup period unless otherwise noted.

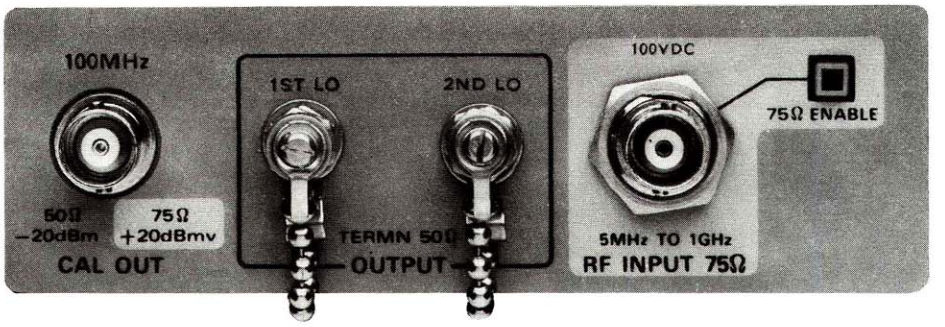
### FREQUENCY RELATED

**Center Frequency Range** — 1 kHz to 1800 MHz.
**Frequency Accuracy** — ±5 MHz +20% of span/div.
**Frequency Readout Resolution*1** — Within 1 MHz. 496P Tune Command Accuracy (Span/div ≤50 kHz): ±7% or ±100 Hz, whichever is greater.
**Delta Frequency Readout Accuracy (Span/Div ≤50 kHz)*1** — ±5%.
**Residual FM (Short Term), Phase Lock On** — ≤10 Hz p-p over 20 ms.
**Residual FM (Short Term), Phase Lock Off** — ≤1 kHz p-p over 20 ms.
**Long Term Drift (at Constant Temperature and Fixed Center Frequency)** — 330 Hz/10 minutes after 1 hour warmup phase locked.
**Resolution Bandwidth (−6 dB)** — 30 Hz, then 100 Hz to 1 MHz in decade steps, plus an Auto position. Resolution bandwidth is within 20% of selected bandwidth.
**Resolution Shape Factor (60 dB/6 dB)** — 7.5:1 or less. 15:1 or less for 30 Hz resolution bandwidth.
**Noise Sidebands** — At least −75 dBc at 30 times the resolution bandwidth offset from the center frequency (−70 dBc for 100 Hz resolution bandwidth or less).
**Frequency Span/Div Range** — From 50 Hz/div to 100 MHz/div in a 1-2-5 sequence.
**Maximum Span** — When selected, the entire effective frequency range is scanned and displayed.
**Zero Span** — When selected, the horizontal axis of the CRT is calibrated in time (instead of frequency). The span/div readout is changed to time/div.
**Frequency Span/Div Accuracy** — Within 5% of the selected span/div over the center 8 div of the 10 div CRT display.
**1 ΔF mode provides measurements to the nearest kHz plus direct center frequency readout to the nearest kHz between 1 kHz and 500 kHz.*

### AMPLITUDE RELATED

**Reference Level Range (Full Screen, Top of Graticule)** — −123 dBm to +40 dBm (+40 dBm includes maximum safe input of +30 dBm and 10 dB of IF gain reduction) for 10 dB/div and 2 dB/div Log modes. 20 nV/div to 2 V/div (1 W maximum safe input) in Lin mode.
**Reference Level Steps** — 10 dB, 1 dB, and 0.25 dB for relative level (Δ) measurements in Log mode. 1-2-5 sequence and 1 dB equivalent increments in Lin mode. The RF attenuator steps 10 dB for reference level changes above −30 dBm (−20 dBm when Minimum Noise is active) unless Minimum RF attenuation is greater than normal. The IF gain increases 10 dB for each Reference Level change below −30 dBm (−20 dBm when Minimum Noise is active).
**Display Dynamic Range** — 80 dB at 10 dB/div, 16 dB at 2 dB/div, and 8 div in Linear mode.
**Reference Level Accuracy** — Accuracy is a function of the following characteristics.
Calibrator: (Cal out). See output signal characteristics.
Input Attenuator Accuracy: 0.3 dB/10 dB to a maximum of 0.7 dB over the 60 dB range, 1 kHz to 1.8 GHz.
Display Amplitude Accuracy: ±1.0 dB/10 dB to a maximum cumulative error of ±2.0 dB over the 80 dB window and ±0.4 dB/2 dB to a maximum cumulative error of ±1.0 dB over the 16 dB window. Lin mode is 5% of full scale.
Resolution Bandwidth Gain Variation: ±0.5 dB.
IF Gain Variation: ±0.2 dB/dB to a maximum of ±2 dB over the 90 dB range.
**Display Flatness** — ±1.5 dB, 1 kHz to 1800 MHz measured with ≥10 dB RF attenuation.
**Sensitivity**

| Resolution Bandwidth | Average Noise Level |
|---|---|
| 30 Hz | −127dBm |
| 100 Hz | −123 dBm |
| 1 kHz | −115 dBm |
| 10 kHz | −105 dBm |
| 100 kHz | −95 dBm |
| 1 MHz | −85 dBm |




*Option 07*

### SPURIOUS RESPONSE

**Residual (No Input Signal)** — −100 dBm or less referenced to mixer input.
**Third-Order Intermodulation Distortion (Minimum Distortion Mode)** — At least −70 dBc below any two on-screen signals within any frequency span.
**Harmonic Distortion (Cw Signal, Minimum Distortion Mode)** — Typically −60 dBc for a full-screen signal.
**Zero Frequency Spur (Referenced to Input Mixer)** — −20 dBm or less.
**LO Emissions (Referenced to Input Mixer)** — −70 dBm maximum.

### INPUT SIGNAL

**RF Input** — Type N female connector.
**Input Impedance** — 50 Ω; vswr 1.3:1 maximum (1.2:1 typical) with 10 dB or more RF attenuation.
**Input Level (Optimum Level for Linear Operation)** — −30 dBm referred to input mixer. Full screen not exceeded and Min Distortion control setting.
**1 dB Compression Point** — −18 dBm, no RF attenuation.
**Maximum Input Level (RF Attenuation at 0 dB)** — +30 dBm.
**Maximum Input Level (with 20 dB or More RF Attenuation)** — +30 dBm (1 W) continuous 75 W peak, pulse width 1 μs or less with a maximum duty factor of 0.001 (attenuation limit). Dc must never be applied to RF input.

### OUTPUT SIGNAL

**Calibrator (Cal Out)** — −20 dBm ±0.3 dB at 100 MHz ±1.7 kHz.
**1st and 2nd LO** — Provides access to the output of the respective local oscillators (1st LO +6 dBm minimum to a maximum of +15 dBm, 2nd LO −16 dBm minimum to a maximum of +15 dBm). These ports must be terminated in 50 Ω at all times.
**Vertical Out** — Provides 0.5 V ±5% of signal/div of video above and below the centerline.
**Horizontal Out** — Provides 0.5 V either side of center. Full range −2.5 V to +2.5 V ±10%.
**Pen Lift** — TTL compatible, nominal +5 V to lift pen.
**IF Out** — Output of the 10 MHz IF. Level is ≈−16 dBm for a full screen signal at −30 dBm input reference level. Nominal impedance 50 Ω.
**496P Only IEEE Standard 488-1978 Port (GPIB)** — In accordance with IEEE Standard 488.
**Probe Power** — Provides operating voltages (+5 V, +15 V, −15 V, and ground) for active probes.

## OPTION 07 CHARACTERISTICS

### 50 Ω INPUT RELATED

Characteristics are the same as the base instruments except for the following:
**300 kHz Resolution Filter** — Replaces the 100 kHz filter.
**Sensitivity** — Average noise level at 300 kHz bw is −90 dBm.

### 75 Ω INPUT RELATED

**Center Frequency Range** — 1 MHz to 1000 MHz.
**Frequency Response** — 5 MHz to 1000 MHz ±2.0 dB. 1 MHz response typically ≤−3 dB from 5 MHz response.
**Reference Level Range** — +88 dBmV to −75 dBmV.
**RF Input** — Type bnc female connector.
**Input Impedance** — 75 Ω; VSWR 1.35:1 maximum; 5 MHz to 800 MHz; VSWR 1.6:1 maximum, 800 MHz to 1000 MHz (with 10 dB or more of RF attenuation).
**Maximum Input Level (0 dB Attenuation)** — +78 dBmV.
**Input Coupling** — 100 Vdc maximum (dc + ac peak).
**Calibrator (Cal Out)** — +20 dBmV ±0.5 dB, 75 Ω at 100 MHz ±1.7 kHz.

### GENERAL CHARACTERISTICS

**Configuration** — (Portable) 496/496P total weight including front cover and standard accessories 20 kg (44 lb), 17.5 cm x 32.7 cm x 49.9 cm (6.9 in x 12.9 in x 19.7 in) without handle or cover.

### ENVIRONMENTAL CHARACTERISTICS

Per MIL-T-28800C, Type III, Class 3, Style C.
For detailed general and environmental specifications refer to the 492 on page 208.

### INCLUDED ACCESSORIES

115 V power cord (161-0118-00); 6 ft N to N connectors 50 Ω coaxial cable (012-0114-00); 18 in BNC to BNC connectors 50 Ω coaxial cable (012-0076-00); N male to BNC female adaptor (103-0045-00); cord clamp (343-0170-00); two 4 A fast blow fuse (159-0017-00); 2 A fast blow fuse (159-0021-00); CRT visor (016-0653-00); CRT mesh filter (378-0726-01); blue CRT light filter (378-0115-00); amber CRT light filter (378-0115-01); gray CRT light filter (378-0115-02); operators manual; service manual; operators handbook; 496P also includes 2 meter double shield GPIB cable (012-0630-03); programmers manual.

## ORDERING INFORMATION

**496** Spectrum Analyzer ..... **$24,080**
**496P** Fully Programmable/GPIB Spectrum Analyzer ..... **$28,630**
**496 to 496P Conversion (040-1046-02)** — Conversions made by your Tektronix Service Center. Contact your Spectrum Analyzer Sales Engineer or Service Center for details ..... **$5,500**
**Option 07** — 75 Ω/50 Ω Input ..... **+$750**
**Option 30** — Rackmount 19 inch rack width with front panel input/outputs ..... **+$790**
**Option 31** — Rackmount 19 inch rack width with rear panel input/output capability ..... **+$840**
**Option 32** — Benchmount adds side and top panels, carrying handles and feet for a stackable benchtop configuration ..... **+$940**

### INTERNATIONAL POWER CORDS & PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 , 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 250 V/10 A, 50 Hz

### OPTIONAL ACCESSORIES

**75 Ω to 50 Ω Minimum Loss Attenuator** — Order 011-0112-00 ..... **$60**
**Dc Block BNC to BNC** — Order 015-0221-00 ..... **$85**
**P6201 FET Probe to 900 MHz** — Order 010-6201-01 .. **$1,210**
**1405 TV Sideband Adaptor** — (525/60 Markers) ..... **$5,780**
For more information on the 1405 see page 215.
**TR 503 Tracking Generator** — ..... **$6,503**
For more information on the TR 503 see page 214.
**C-5C Camera** — ..... **$495**
**TV Trigger Synchronizer** — Order 015-0261-01 ..... **$395**
**Hard Case (transit)** — Order 016-0658-00 ..... **$625**
**Soft Case** — Order 016-0659-00 ..... **$125**
**Lab Cart Model 3** — ..... **$595**
*Note: The 490 Series spectrum analyzers are compatible with all Tektronix C-50 Series cameras. Battery pack 016-0270-02 is required for C-50, C-51, C-52 and C-53 cameras.*

### PERIPHERAL PRODUCTS FOR 494P SPECTRUM ANALYZER

**4041** System Controller (See page 324) ..... **$3,995**
**4105** Color Terminal (See page 55) ..... **$3,995**
**4695** Color Graphics Copier (See page 68) ..... **$1,595**
**6120** Scientific Desktop Computer (See page 48) ..... **$7,995**

GPIB IEEE-488 **492P** **492**

The 492P complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**Microprocessor Aided Controls**

**Automatic Modes**

**Portable Form Factor (Compact Size/Lightweight)**

**50 kHz to 220 GHz Frequency Range**

**Amplitude Comparison in 0.25 dB Steps**

**CRT Readout of All Important Parameters**

**Fully Calibrated in Amplitude and Frequency**

**80 dB Dynamic Range**

**Wide Range of Options**

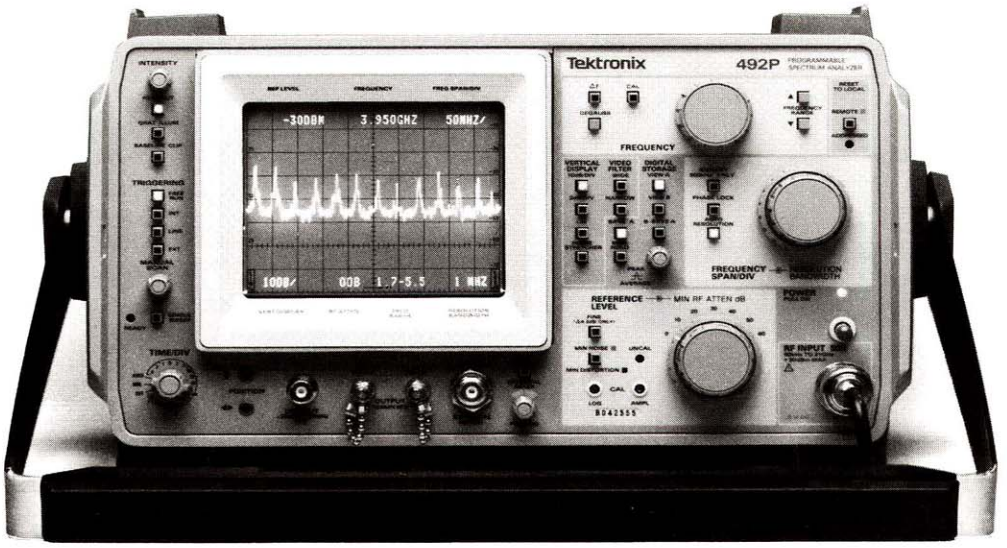
**GPIB/Fully Programmable (492P)**

**Three-Knob Operation**

**Environmentalized per MIL-T-28800C**

**Digital Storage and Signal Processing**

**Freedom from Spurious Responses Through Preselection**




### Lab Quality You Can Get a Handle On

The 492 is a high performance, rugged, state-of-the-art instrument of compact size, with microprocessor logic control. Full programmability via GPIB (IEEE Standard 488-1978) compatibility is available in the 492P version.

Three-knob operation provides use as simple as 1, 2, 3 through microprocessor coupled functions such as resolution bandwidth, video bandwidth, sweep time, frequency span, RF attenuation, and reference level. Measurement accuracy is enhanced through the use of Δ dB mode, which switches in 0.25 dB steps.

Digital storage and processing facilitate trace comparisons and add measurement capability through the Max Hold function for frequency drift and amplitude change measurements. Arithmetic operations can be performed between traces or between a trace and a reference. Digital noise averaging mode results in trace smoothing. With digital storage, the display is steady and without flicker, even at the lowest sweep speeds; plus trace values may be retained as long as power is on.

### 492P Makes Spectrum Analysis Automatic, and Easy.

Two instruments in one, the 492P is a fully programmable version of the 492 Spectrum Analyzer. It incorporates all of the 492's lab quality performance and ease of use features when used as a manual instrument. Push the "Reset to Local" button and the 492P becomes a 492—with operation from the front panel. But, most important, the 492P opens the way to automated spectrum analysis and documentation via its IEEE Standard 488 (GPIB) interface. This versatility makes the 492P useful in many applications in the lab, factory or field.

### Add Programmability

Programmability/GPIB features can be added to 492 Spectrum Analyzers. This means if you want to postpone a programmability/GPIB decision because of budget constraints, or for any other reason, you can convert your 490 Series spectrum analyzer later. Conversions are made at designated Tektronix Service Centers.

### Remotely Controllable via GPIB

Switches on the rear panel select the mode of operation as a GPIB instrument. In the normal Talker/Listener mode, the 492P listens to and executes commands from a GPIB controller. All important front panel settings can be operated remotely. Some functions are controlled with more detail through the GPIB than possible from the front panel.

### Easy to Use

The 492P is designed for ease of operation via the GPIB, just as the 492 is designed for front panel operational ease. Most commands for program control are simply abbreviations of the front panel nomenclature.

The 492P's high level command language and the similarity of commands and responses simplify programming and make program listings easily readable for editing.

### Put it to Work

With the programmable 492P on your measurement team, repetitive measurements can be done the same way every time. Your throughput will increase—and your confidence in results. And, the internal processing and high level programming language makes software development faster. You get high power results with easy programming. When you look at the total performance capability of the 492P, you'll recognize its value: ease of operation both as a programmable and manual instrument. Wide frequency range. The versatility to go where you go. Into the lab for automated testing; into the field for data collection.

For more information on the application and benefits of the 490 Series Spectrum Analyzers under program control, ask for brochure 26W-5177.

## CHARACTERISTICS

The following characteristics and features apply to the 492/492P Spectrum Analyzers after a 30 minute warmup period unless otherwise noted.

**FREQUENCY RELATED**

**Center Frequency Range** — 50 kHz to 21 GHz standard, amplitude specified coverage to 220 GHz with optional Tektronix waveguide mixers.

**Frequency Accuracy** — ±(5 MHz +20% of span/div) or ±(0.2% of the center frequency +20% of span/div) whichever is greater after 2 hour warmup.

**Readout Resolution** — Within 1 MHz.

**Frequency Span/Div Range** — 10 kHz to 500 MHz/Div in a 1-2-5 sequence in the 50 kHz to 21 GHz Center Frequency Range. Option 03 provides additional span ranges of 500 Hz, 1 kHz, 2 kHz, and 5 kHz/Div.

**Span Accuracy** — ±5% of span/div, measured over center 8 div.

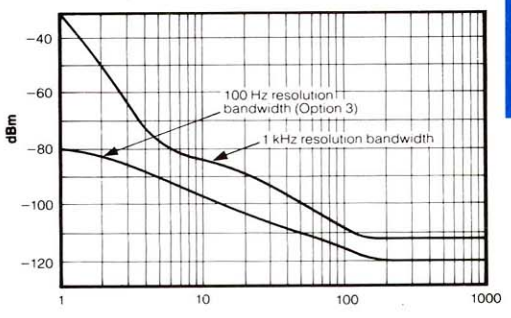
**Resolution Bandwidth (−6 dB Points)** — 1 MHz to 1 kHz (100 Hz for Option 03) in decade steps, plus an Auto position. Resolution is within 20% of selected bandwidth.

**Resolution Shape Factor (60 dB/6 dB)** — 7.5:1 or less.

**Residual FM** — 1 kHz p-p for 2 ms time duration, improves to (50 Hz) for 20 ms with phaselock Option 03.

**Long Term Drift (At Constant Temperature and Fixed Center Frequency)** — 3 kHz/10 minutes after one hour warmup with Option 03 for fundamental mixing.

**Noise Sidebands** — At least −75 dBc at 30X Resolution offset from the center frequency (−70 dBc for 100 Hz resolution bandwidth Option 03).




*Typical low end frequency performance for the 492 with Option 03.*

## SENSITIVITY AND FREQUENCY RESPONSE

| Frequency Range | Mixing Number (n) | Average Noise Level for 1 kHz Resolution: No Preselection | Average Noise Level for 1 kHz Resolution: Preselected Option 01 | Frequency Response With 10 dB Attenuation: No Preselection | Frequency Response With 10 dB Attenuation: Preselected Option 01 |
|---|---|---|---|---|---|
| 50 kHz to 1.8 GHz* | 1 | −115 dBm | −110 dBm | | ±1.5 dB |
| 50 kHz to 4.2 GHz* | 1 | −115 dBm | −110 dBm | ±1.5 dB | |
| 1.7 GHz to 5.5 GHz | 1 | −115 dBm | −110 dBm | ±1.5 dB | ±2.5 dB |
| 3.0 GHz to 7.1 GHz | 1 | −115 dBm | −110 dBm | ±1.5 dB | ±2.5 dB |
| 5.4 GHz to 18 GHz | 3 | −100 dBm | −95 dBm (12 GHz)<br>−90 dBm (18 GHz) | ±2.5 dB | ±3.5 dB |
| 15 GHz to 21 GHz | 3 | −95 dBm | −85 dBm | ±3.5 dB | ±5.0 dB |
| 100 MHz to 18 GHz*** | | | | ±3.5 dB | ±4.5 dB |
| **WITH TEKTRONIX OPTIONAL HIGH PERFORMANCE WAVEGUIDE MIXERS** | | | | | |
| 18 GHz to 26 GHz | 6 | −100 dBm | | ±2.0 dB | |
| 26 GHz to 40 GHz | 10 | −95 dBm | | ±2.0 dB | |
| 33 GHz to 50 GHz | 10 | −95dBm | | ±2.0 dB | |
| 40 GHz to 60 GHz | 10 | −95 dBm | | ±2.5 dB | |
| 60 GHz to 90 GHz | 15 | −95 dBm @ 60 GHz† | | ±3.0 dB**† | |
| | | −85 dBm @ 90 GHz† | | ±3.0 dB**† | |
| 90 GHz to 140 GHz | 23 | −85 dBm @ 90 GHz† | | ±3.0 dB**† | |
| | | −75 dBm @ 140 GHz† | | ±3.0 dB**† | |
| 140 GHz to 220 GHz | 37 | −65 dBm @ 220 GHz† | | ±3.0 dB**† | |

** Low frequency end performance does not include effects due to 0 Hz feedthrough.*

*** Over any 5 GHz bandwidth.*

**** Includes frequency band switching error of 1 dB maximum.*

*† Typical*

### AMPLITUDE RELATED

**Reference Level Range** — Full screen, top of graticule −123 dBm to +40 dBm (+40 dBm, includes maximum safe input of +30 dBm and 10 dB gain of IF gain reduction) for 10 dB/div and 2 dB/div log modes. 1 W maximum safe input in the linear mode.

**Reference Level Steps** — 10 dB, 1 dB, and 0.25 dB for relative level (Δ) measurements in Log mode. 1-2-5 sequence and 1 dB equivalent increments in Lin mode. The RF attenuator steps 10 dB for reference level changes above −30 dBm (−20 dBm when minimum noise is active) unless minimum RF attenuation is greater than normal. The IF gain increases 10 dB for each reference level change below −30 dBm (−20 dBm when minimum noise is active).

**Display Dynamic Range** — 80 dB at 10 dB/div, 16 dB at 2 dB/div and 8 div in linear mode.

**Reference Level Accuracy** — Accuracy is a function of the characteristics listed below.

**Calibrator** — (Cal out) See output signal characteristics.

**Input Attenuator Accuracy** — 0.3 dB/10 dB to a maximum of 0.7 dB over the 60 dB range, up to 4 GHz; 0.5 dB/10 dB to a maximum of 1.4 dB over the 60 dB range from 4 GHz to 21 GHz.

**Frequency Response** — See frequency response table above.

**Display Amplitude Accuracy** — ±1.0 dB/10 dB to a maximum cumulative error of ±2.0 dB over the 80 dB window and ±0.4 dB/2 dB to a maximum cumulative error of ±1.0 dB over the 16 dB window. Lin Mode is 5% of full scale.

**Resolution Bandwidth Gain Variation** — ±0.5 dB.

**IF Gain Variation** — ±0.2 dB/dB to a maximum of ±2 dB over the 90 dB range.

### SPURIOUS RESPONSES

**Residual (No Input Signal Referenced to Mixer Input)** — −100 dBm or less.

**Harmonic Distortion (cw Signal, Minimum Distortion Mode)** — Typically −60 dBc for full screen signal in the minimum distortion mode to 21 GHz. At least −100 dBc for preselected Option 01. 1.7 GHz to 21 GHz.

**Third-Order Intermodulation Distortion (Minimum Distortion Mode)** — At least 70 dB down from two full screen signals within any frequency span. At least 100 dB down for two signals spaced more than 100 MHz apart from 1.7 GHz to 21 GHz for preselected Option 01.

**LO Emissions (Referenced to Input Mixer)** — −10 dBm maximum; −70 dBm maximum to 21 GHz for Option 01.

### INPUT SIGNAL CHARACTERISTICS

**RF Input** — Type N female connector.

**Input Impedance** — 50 Ω.

**Maximum VSWR*1 with ⩾10 dB Attenuation**

| Frequency Range | Typical | Specified Maximum |
|---|---|---|
| Dc to 2.5 GHz | 1.2:1 | 1.3:1 |
| 2.5 GHz to 6.0 GHz | 1.5:1 | 1.7:1 |
| 6.0 GHz to 18 GHz | 1.9:1 | 2.3:1 |
| 18 GHz to 21 GHz | 2.7:1 | 3.5:1 |

**1 At Type N female connector to internal mixer*

**Input Level (Optimum Level for Linear Operation)** — −30 dBm referenced to input mixer. Full screen not exceeded and minimum distortion control settings.

**1 dB Compression Point** — −18 dBm.

**Maximum Safe Input Level (RF Attenuation at Zero dB)** — +13 dBm without Option 01. +30 dBm (1 W) with Option 01.

**Maximum Input Level (with 20 dB or more RF Attenuation)** — +30 dBm (1 W) continuous, 75 W peak for 1 μs or less pulse width and 0.001 maximum duty factor (attenuation limit). Dc must never be applied to RF input.

### OUTPUT SIGNAL CHARACTERISTICS

**Calibrator (Cal Out)** — −20 dBm ±0.3 dB, 100 MHz ±1.7 kHz.

**1st and 2nd LO** — Provides access to the output of the respective local oscillators (1st LO +7.5 dBm minimum to a maximum of +15 dBm; 2nd LO −22 dBm minimum to a maximum of +15 dBm). These ports must be terminated in 50 Ω at all times.

**Vertical Out** — Provides 0.5 V ±5% of signal/div of video above and below the center line.

**Horizontal Out** — Provides 0.5 V either side of center. Full range −2.5 V to +2.5 V ±10%.

**Pen Lift** — TTL, +5 V nominal to lift pen.

**IF Out** — Output of the 10 MHz IF. Level is approximately −16 dBm for a full screen signal at −30 dBm input reference level. Nominal impedance 50 Ω.

**492P Only: IEEE Standard 488-1978 Port (GPIB)** — In accordance with IEEE Standard 488.

### GENERAL CHARACTERISTICS

**Sweep Time** — 20 μs to 5 s/div (10 s/div in auto) in 1-2-5 sequence.

**CRT Readout** — Displays reference level, center frequency, frequency range, vertical display mode, frequency span/div resolution bandwidth and RF attenuation.

**CRT** — 8 x 10 cm, GH (P31) Phosphor.

**Input Voltage** — 90 V ac to 132 V ac or 180 V ac to 250 V ac, 48 Hz to 440 Hz.

**Power** — 210 W maximum with all options, at 115 V and 60 Hz.

### ENVIRONMENTAL CHARACTERISTICS

Per MIL-T-28800C Type III, Class 3, Style C.

**Temperature** — Operating: −15°C to +55°C. Nonoperating: −62°C to +85°C.

**Humidity** — Operating: 95%. Nonoperating: 120 hours per MIL-STD-810.

**Rain Resistance** — Drip proof at 16 liters/hour/square foot.

**Altitude** — Operating: 4500 m (15,000 ft). Nonoperating: 12 000 m (40,000 ft).

**Vibration** — 15 Hz to 55 Hz at 0.025 inch excursion.

**Shock** — 30 g of half sine 11 ms duration.

**Drop** — 12 inches.

**Electromagnetic Compatibility** — 490 Series spectrum analyzers meet the requirements of MIL-STD-461B, operating from 48 Hz to 440 Hz power sources, with the exceptions shown below.

**Conducted Emissions** — CE01: 15 dB relaxation for first 10 harmonics of power line frequency. CE03 (Narrowband): Full limits. CE03 (Broadband): 15 dB relaxation from 15 kHz to 50 kHz.

**Conducted Susceptibility** — CS01: Full limits. CS02: Full limits. CS06: Full limits.

**Radiated Emissions** — RE01: 10 dB relaxation for first 10 harmonics of power line frequency, and exceptioned from 30 kHz to 36 kHz. RE02: Full limits.

**Radiated Susceptibility** — RS01: Full limits. RS02-1: Full limits. RS02-2: To 5 A only. RS03: Up to 1 GHz only.

**Configuration** — Portable. 492/492P Option 01, 02, 03 total weight including front cover and standard accessories. 20 kg (49 lb), 17.5 cm x 32.7 cm x 49.9 cm (6.9 in x 12.9 in x 19.7 in) without handle or cover.

### INCLUDED ACCESSORIES

6 ft N to N connector 50 Ω coaxial cable, (012-0114-00); 18 in BNC to BNC connector 50 Ω coaxial cable (012-0076-00); N male to BNC female adaptor (103-0045-00); CRT mesh filter (378-0726-01); 2 A fast blow fuse (159-0021-00); two 4 A fast blow fuse (159-0017-00); 115 V power cord (161-0118-00); cord clamp (343-0170-00); CRT visor (016-0653-00); diplexer assembly (015-0385-00); amber CRT light filter (378-0115-01); blue CRT light filter (378-0115-00); gray CRT light filter (378-0115-02); operators manual; operators handbook; service manual, programmers manual.

## ORDERING INFORMATION

**492** Spectrum Analyzer ..... **$23,220**

**492P** Fully Programmable/GPIB/Digital Storage Spectrum Analyzer ..... **$31,375**

**492 to 492P Conversion** — Conversion made by your Tektronix Service Center. For 492's with Options 01, 02, 03, 08. Order 040-1038-02 ..... **$7,560**
For 492's with Options 01, 02, 03. Order 040-1037-03 .. **$7,560**

**Option 01** — Internal Preselection. Provides calibrated preselected filtering of input to first mixer for each frequency band ..... **+$3,995**

**Option 02** — Digital Storage (492 Only). Provides multiple memory display storage with Save A, maximum hold, B minus Save A, display averaging, and storage bypass ..... **+$1,950**

**Option 03** — Frequency Stabilization/100 Hz Resolution. Provides first local oscillator stabilization by phase locking the oscillator to an internal reference ..... **+$3,590**

**Option 08** — Delete External Mixer Capability. Deletes internal switching front panel connector and external diplexer to connect and use external wavequide mixers ..... **−$1,750**

**Option 11** — Automatic Preselector Peaking. Provides 492P's with calibration routine to store peak preselector values in bands 2, 3, and 4 ..... **$450**

**Option 20** — General Purpose 12.4 GHz to 40 GHz Waveguide Mixer Set. Includes three mixers (12.4 GHz to 18 GHz, 18 GHz to 26.5 GHz, and 26.5 GHz to 40 GHz) and attaching hardware to extend the upper frequency ..... **+$900**

**Option 21** — High Performance 18 GHz to 40 GHz Waveguide Mixer Set. Includes two mixers (18 GHz to 26.5 GHz and 26.5 GHz to 40 GHz) and attaching hardware to extend the upper frequency ..... **+$2,525**

**Option 22** — High Performance 18 GHz to 60 GHz Waveguide Mixer Set. Includes three mixers (18 GHz to 26.5 GHz, 26.5 GHz to 40 GHz, and 40 GHz to 60 GHz) and attaching hardware to extend the upper frequency ..... **+$4,250**

**Option 30** — Rackmount. 19 inch rack width with front panel input/outputs ..... **+$790**

**Option 31** — Rackmount. 19 inch rack width with rear panel input/output capability ..... **+$840**

**Option 32** — Benchmount. Adds side and top panels, carrying handles and feet for a stackable bench top configuration ..... **+$940**

**Option 41** — Digital Radio. Provides wider bandwidth preselector, 30 Hz video filter with 100 kHz resolution bandwidth and 5 MHz Span/Div optimized for 6 and 11 GHz D/R ..... **$450**

**Option 42** — 110 MHz IF Output. Provides 5 MHz bandwidth at 6 dB points ..... **$1,500**

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

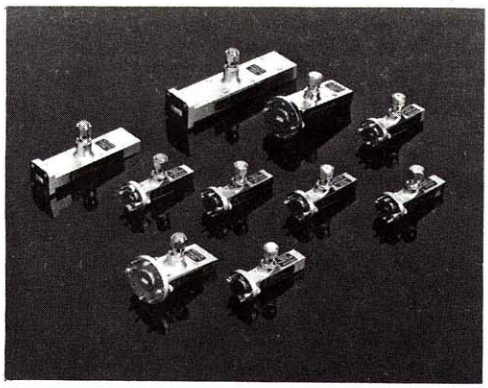
**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

### OPTIONAL ACCESSORIES

**Microwave Comb Generator TM 500 Series Compatible** — Order 067-0885-00 ..... **$1,800**
**75 Ω to 50 Ω Minimum Loss Attenuator** — Order 011-0112-00 ..... **$60**
**Dc Block BNC to BNC** — Order 015-0221-00 ..... **$85**
**P6201 FET Probe to 900 MHz** — Order 010-6201-01 **$1,210**
**1405 TV Sideband Adaptor** — (525/60 Markers) ..... **$5,780**
For more information on the 1405 see page 215.
**TR 503 Tracking Generator** — ..... **$6,620**
For more information on the TR 503 see page 214.
**C-5C Camera** — ..... **$495**
**TV Trigger Synchronizer** — Order 015-0261-01 ..... **$395**
**Hard Case (transit)** — Order 016-0658-00 ..... **$625**
**Soft Case** — Order 016-0659-00 ..... **$125**
**Lab Cart Model 3** — ..... **$595**
*Note: The 490 Series spectrum analyzers are compatible with all Tektronix C-50 Series cameras. Battery pack 016-0270-02 is required for C-50, C-51, C-52 and C-53 cameras.*

### PERIPHERAL PRODUCTS FOR 492P SPECTRUM ANALYZER

**4041** System Controller (See page 324) ..... **$3,995**
**4105** Color Terminal (See page 55) ..... **$3,995**
**4695** Color Graphics Copier (See page 68) ..... **$1,595**
**6120** Scientific Desktop Computer (See page 48) ..... **$7,995**



## 490 Series Waveguide Mixers

The 490 Series Tektronix Waveguide Mixers cover from 18 GHz to 325 GHz with optimum sensitivity. They are designed specifically for use with the Tektronix 490 Series and 7L18 Spectrum Analyzers.

The two microwave mixers cover ranges 18 GHz to 26.5 GHz and 26.5 GHz to 40 GHz. They have field replaceable diodes and frequency response of ±2 dB when used with the spectrum analyzers indicated above.

Eight millimeter wave mixers cover the 33 GHz to 220 GHz range in the standard Mil-spec band ranges. J to G band flange transition (119-1728-00) converts the WM 490G mixer to cover the 220 GHz to 325 GHz range.

The mixers are all gold plated brass, conforming to MIL-G-45204 Class I, Type 1 specifications and will withstand harsh environments. Each set comes complete with a container for spare diodes, a 28-inch cable, an instruction manual and a wood storage box with foam cutout storage locations for five mixers.

### CHARACTERISTICS

**For All Waveguide Mixers** — Maximum cw RF input level: +20 dBm (100 mW).

**Maximum PULSED RF Input Level** — 1 W peak with 0.001 maximum duty factor and 1 μs maximum pulse width.

**LO Requirement** — +7 dBm minimum, +15 dBm maximum, +10 dBm typical.

**Bias Requirement** — −2.0 V to +0.5 V with respect to the mixer body through a current limiting resistor, to provide 0 mV to 20 mA of bias current.

**1 dB Compression Point** — +13 dBm typical.

**For the 18 GHz to 60 GHz Waveguide Mixers** — Amplitude Accuracy ±6 dB maximum reference level error with respect to the internal calibrator.

**INDIVIDUAL MIXER ELECTRICAL CHARACTERISTICS**

| Frequency Range (GHz) | Tektronix Model No | Band Designation | Sensitivity (dBm)*1 | Frequency Response*2 | Conversion Loss*3 Typical |
|---|---|---|---|---|---|
| 18 to 26.5 | WM 490K | K | −100 | ±2 dB | −30 dB |
| 26.5 to 40 | WM 490A | A | −95 | ±2 dB | −30 dB |
| 33 to 50 | WM 490Q *NEW* | Q | −95 | ±2 dB | −30 dB |
| 40 to 60 | WM 490U | U | −95 | ±2.5 dB | −30 dB |
| 50 to 75 | WM 490V | V | −95 at 50 GHz<br>−90 at 75 GHz<br>typical | ±3 dB<br>typical*4 | −30 dB at 50 GHz<br>−35 dB at 75 GHz |
| 60 to 90 | WM 490E | E | −95 at 60 GHz<br>−85 at 90 GHz<br>typical | ±3 dB<br>typical*4 | −30 dB at 60 GHz<br>−40 dB at 90 GHz |
| 75 to 110 | WM 490W | W | −90 at 75 GHz<br>−80 at 110 GHz<br>typical | ±3 dB<br>typical*4 | −35 dB at 75 GHz<br>−45 dB at 110 GHz |
| 90 to 140 | WM 490F | F | −85 at 90 GHz<br>−75 at 140 GHz<br>typical | ±3 dB<br>typical*4 | −40 dB at 90 GHz<br>−50 dB at 140 GHz |
| 110 to 170 | WM 490D | D | −80 at 110 GHz<br>−70 at 170 GHz<br>typical | ±3 dB<br>typical*4 | −45 dB at 110 GHz<br>−55 dB at 170 GHz |
| 140 to 220 | WM 490G | G | −75 at 140 GHz<br>−65 at 220 GHz<br>typical | ±3 dB<br>typical*4 | −50 dB at 140 GHz<br>−60 dB at 220 GHz |
| 220 to 325 | 119-1728-00[6] *NEW* | J | −65 at 220 GHz<br>−50 at 325 GHz<br>typical[5] | ±3 dB | −60 dB at 220 GHz<br>−70 dB at 325 GHz |

**1 Equivalent average noise level at 1 kHz bandwidth.*

**2 Maximum amplitude variation across each waveguide mixer band (with peaking control optimized at each frequency in response to a −30 dBm CW input signal to the mixer).*

**3 490 LO drive +10 dBm peaking control optimized.*

**4 Over any 5 GHz bandwidth for millimeter wave mixers above 60 GHz.*

**5 Value estimated at 325 GHz.*

**6 Tapered waveguide transition allowing WM 490G to cover this range.*

**INDIVIDUAL MIXER MECHANICAL CHARACTERISTICS**

| Frequency Range (GHz) | Tektronix Model No | Waveguide (EIA) | Flange (JAN) | Length | Width*1 | Height*1 | Weight |
|---|---|---|---|---|---|---|---|
| 18 to 26.5 | WM 490K | WR-42 | UG-595/U | 8.97 cm (3.53 in) | 2.22 cm (.875 in) | 3.68 cm (1.45 in) | 180 g (6.5 oz) |
| 26.5 to 40 | WM 490A | WR-28 | UG-599/U | 6.93 cm (2.73 in) | 1.90 cm (.750 in) | 3.35 cm (1.32 in) | 100 g (3.7 oz) |
| 33 to 50 | WM 490Q | WR-22 | UG-383/U | 5.37 cm (2.125 in) | 1.84 cm (.725 in) | 2.82 cm (1.110 in) | 90 g (3.3 oz) |
| 40 to 60 | WM 490U | WR-19 | UG-383/U-M | 4.52 cm (1.78 in) | 1.84 cm*1 (.725 in) | 2.45 cm (.980 in) | 80 g (2.9 oz) |
| 50 to 75 | WM 490V | WR-15 | UG-385/U | 4.31 cm (1.70 in) | 0.89 cm (.350 in) | 2.29 cm (.900 in) | 40 g (1.5 oz) |
| 60 to 90 | WM 490E | WR-12 | UG-387/U | 4.31 cm (1.70 in) | 0.89 cm (.350 in) | 2.29 cm (.900 in) | 40 g (1.5 oz) |
| 75 to 110 | WM 490W | WR-10 | UG-387/U-M | 4.31 cm (1.70 in) | 0.89 cm (.350 in) | 2.29 cm (.900 in) | 40 g (1.5 oz) |
| 90 to 140 | WM 490F | WR-08 | UG-387/U-M[2] | 4.31 cm (1.70 in) | 0.89 cm (.350 in) | 2.29 cm (.900 in) | 40 g (1.5 oz) |
| 110 to 170 | WM 490D | WR-06 | UG-387/U-M[2] | 4.31 cm (1.70 in) | 0.89 cm (.350 in) | 2.29 cm (.900 in) | 40 g (1.5 oz) |
| 140 to 220 | WM 490G | WR-05 | UG-387/U-M[2] | 4.31 cm (1.70 in) | 0.89 cm (.350 in) | 2.29 cm (.900 in) | 40 g (1.5 oz) |
| 220 to 325 | 119-1728-00 G-J Band flange transition | WR-05<br>WR-03 | 74-003<br>74-005 | — | — | — | — |

**Notes:**

1. *Physical dimensions exclude contribution due to the diameter of round waveguide flanges in U, V, E, W, F, D and G bands.*
2. *All mixers are equipped with standard UG-XXX/U type flanges as indicated. Flange adaptors to standard MIL-F-3922 type flanges are provided in F, D, and G bands at no additional charge.*
3. *All mixers include a protective flange cover, an LO/IF port protective shorting cap, and two captive flange screws for round flange mixers.*

### ORDERING INFORMATION

**Performance Specified Mixers and Sets:**

**18 GHz to 26.5 GHz Frequency Range** —
Order WM 490K ..... **$1,250**

**26.5 GHz to 40 GHz Frequency Range** —
Order WM 490A ..... **$1,250**

**33 GHz to 50 GHz Frequency Range** —
Order WM 490Q ..... **$1,450**

**40 GHz to 60 GHz Frequency Range** —
Order WM 490U ..... **$1,720**

**50 GHz to 75 GHz Frequency Range** —
Order WM 490V ..... **$1,950**

**60 GHz to 90 GHz Frequency Range** —
Order WM 490E ..... **$2,120**

**75 GHz to 110 GHz Frequency Range** —
Order WM 490W ..... **$2,175**

**90 GHz to 140 GHz Frequency Range** —
Order WM 490F ..... **$2,330**

**110 GHz to 170 GHz Frequency Range** —
Order WM 490D ..... **$3,250**

**140 GHz to 220 GHz Frequency Range** —
Order WM 490G ..... **$3,325**

**220 GHz to 325 GHz Frequency Range** —
G-J Band Flange Transition (Used with WM 490G). Order 119-1178-00

**18 GHz to 40 GHz Set Contains WM 490K, WM 490A** —
Order WM 4902 ..... **$2,550**

**18 GHz to 60 GHz Set Contains WM 490K, WM 490A and WM 490U** — Order WM 4903 ..... **$4,300**

**18 GHz to 90 GHz Set Contains WM 490K, WM 490A, WM 490U and WM 490E** — Order WM 4904 ..... **$6,420**

**18 GHz to 140 GHz Set Contains WM 490K, WM 490A, WM 490U, WM 490E, and WM 490F** —
Order WM 4905 ..... **$8,750**

**Cable** — Order 012-0649-00 ..... **$25**

**Case** — Order 016-0465-01 ..... **$45**

**140 GHz to 220 GHz** tapered transition 119-1729-00 used with WM 490F waveguide mixer ..... **$475**

**General Purpose Waveguide Mixer and Set:**

**12.5 GHz to 18 GHz Frequency Range** —
Order 119-0097-01 ..... **$200**

**18 GHz to 26.5 GHz Frequency Range** —
Order 119-0098-01 ..... **$300**

**26.5 GHz to 40 GHz Frequency Range** —
Order 119-0099-01 ..... **$380**

**Cable** — Order 012-0748-00 ..... **$31**

**Case** — Order 016-0465-01 ..... **$45**

**12.5 GHz to 40 GHz** — Set contains 119-0097-01, 119-0098-01, 119-0099-01. Order 016-0640-00 ..... **$940**

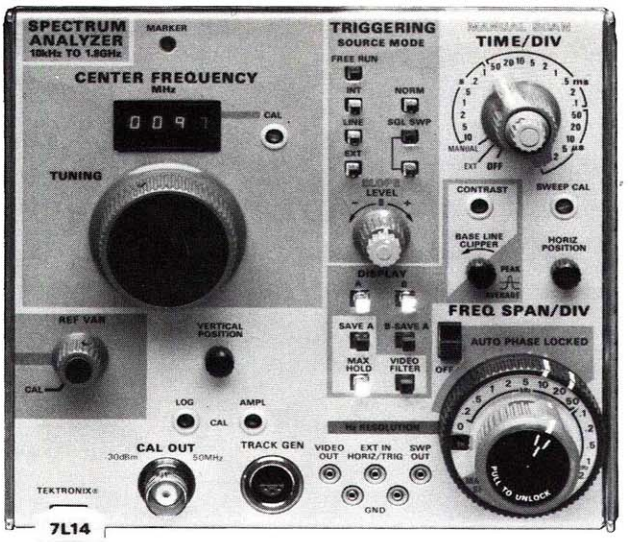
## 7L14

**Digital Storage and Averaging**

**Automatic Phase Lock**

**Swept Frequency Measurements with TR 502**

**Input Limiter for Extra Input Protection**




The Tektronix 7L14 is a VHF/UHF analyzer with digital storage. It provides high performance in the 10 kHz to 1.8 GHz range. Measurements for RFI/EMI, FM, TV, avionics, navigation, two-way and other communications systems are made with accuracy and convenience.

Resolution bandwidth can be varied from 30 Hz to 3 MHz over the entire frequency range. Automatic phase lock ensures excellent stability—incidental FM is ≤13 Hz p-p. Phase noise sidebands are no greater than −70 dBc at 25 resolution bandwidths away.

All this gives you the critical accuracy necessary for design and proof-of-performance measurements. Check broadband RF networks, filter networks, amplifiers, and more...easily and economically.

Digital storage expands 7L14 capability. You can compare waveforms, such as a filter response to a standard, simultaneously using independent A and B memories. A Max Hold function makes it easy to measure amplitude and frequency drift such as in an oscillator; or capture short duration signals such as in spectrum occupancy monitoring.

An input limiter provides overload protection of the first mixer. Signals up to one watt can be connected to the input for any setting of the RF input attenuator. In addition, the input is ac-coupled for protection from dc and large voltages at line frequency (50 Hz/60 Hz). Frequency coverage down to 1 kHz can be obtained by deleting the built-in limiter Option 23. Also, by ordering Option 39 you can extend the 7L14's frequency range from 1 kHz to 2.5 GHz. This is useful for satellite communications measurements, on multipoint distribution systems and other terrestrial microwave applications.

Using the 7L14 with a companion TR 502 Tracking Generator, you can make swept frequency measurements from 100 kHz to 1.8 GHz. For detailed information, refer to page 214.

### CHARACTERISTICS

The following characteristics and features apply to the 7L14 Spectrum Analyzer after a warm up period of 20 minutes.

#### FREQUENCY RELATED

**Center Frequency Range** — 10 kHz to 1.8 GHz.
**Readout Resolution** — Within 1 MHz.
**Readout Accuracy** — ±(5 MHz + 20% of frequency span/div).
**Frequency Span** — 200 Hz/div to 100 MHz/div in calibrated steps in a 1-2-5 sequence.
**Accuracy** — Within 5% of the span selected.
**Linearity** — Within 5% of the span selected.
**Maximum Span** — Provides 1.8 GHz of span.
**Zero Span** — Provides fixed frequency operation for time domain display.
**Resolution Bandwidth**
**Range** — 30 Hz to 3 MHz, in decade steps.
**Accuracy (6 dB down)** — Within ±20% of the resolution selected.
**Shape Factor (60/6 dB)** — 4:1 or less for 3 MHz to 300 Hz; 12:1 or less for 30 Hz resolution.
**Signal Level Change Between Any Two Bandwidths** — ±0.5 dB at room temperature. ±2.0 dB maximum over temperature.
**Residual FM** — 13 Hz (p-p) when phase locked ±10 kHz (p-p) for 20 ms when not phase locked.
**Stability** — At a fixed temperature after two hour warm up; ±2 kHz/hour phase locked; ±75 kHz/hour not phase locked. At constant frequency, wait 10 minutes/GHz of tuning when the frequency is changed.

#### AMPLITUDE RELATED

**Display Modes**
**Log 10 dB/div** — Provides 70 dB display dynamic range. Accuracy within 0.15 dB/dB to 2 dB maximum over 70 dB dynamic range.
**Log 2 dB/div** — Provides 14 dB display dynamic range. Accuracy within ±0.4 dB/2 dB to 1.0 dB maximum over 14 dB dynamic range.
**LIN** — Within 10% over 8 divisions. Deviation between display modes (for full screen signal): ±2 dB from 2 dB/div to 10 dB/div, 0.5 div from 2 dB/div to LIN.
**Reference Level**
**Below 100 kHz** — +30 dBm to −50 dBm, as the center frequency approaches 10 kHz.
**Above 100 kHz** — +30 dBm to −110 dBm in 10 dB calibrated steps.
**Display Flatness** — ±1.5 dB, with respect to 50 MHz, over any selected frequency span.
**Sensitivity** — At 50 MHz, applicable from 100 kHz to 1.8 GHz.

| Resolution Bandwidth | Averaged Input Noise Level |
|---|---|
| 30 Hz | −130 dBm |
| 300 Hz | −120 dBm |
| 3 kHz | −110 dBm |
| 30 kHz | −100 dBm |
| 300 kHz | −90 dBm |
| 3 MHz | −80 dBm |

#### SPURIOUS RESPONSES

**Residual** — < −100 dBm (referenced to the 1st mixer input).
**Second Order Intermodulation Products** — 100 kHz −1.8 GHz; down 70 dBc or more from two −40 dBm signals, within any frequency span.
**Third Order Intermodulation Products** — 100 kHz −1.8 GHz; down 70 dBc or more from two −30 dBm signals, within any frequency span.
**RF Attenuator** — 60 dB range in 10 dB steps.
**Accuracy** — ±(0.25 dB +1.2% of dB reading).
**IF Gain**
**Range** — 70 dB (80 dB when operating in 30 Hz resolution bandwidth).
**Step Accuracy** — ±1 dB/10 dB step to ±2 dB maximum over entire range.

#### GENERAL CHARACTERISTICS

**Noise Sidebands** — −70 dBc minimum at frequency offsets ≥25 X resolution bandwidth settings.
**Sweep** — Triggered, manual, external.
**Sweep Time** — 10 s/div to 1 μs/div in a 1-2-5 sequence.
**Accuracy** — ±5% of selected Time/div.
**Triggering Modes** — Internal, External, Ext in Horiz/Trig and Line.
**Sensitivity** — ±0.6 div of internal signal (p-p) and/or ±0.6 V (p-p) of external signal.
**Shipping Weight** — 10.8 kg (24 lb).

#### INPUT SIGNAL CONNECTORS

**RF Input** — Maximum Input Power Level: +30 dBm. Maximum Input Power Level to the RF Attenuator ≥10 dB: 1 W average (including dc), 100 W peak simultaneously. Input Impedance: 50 Ω; vswr 1.35 maximum with 10 dB of RF attenuation.
**External Horizontal/Trigger Input Connector** — Input Voltage Range: Typically 0 V to 10 V for 10 div sweep. Typically 0.5 V (p-p) to trigger the sweep circuits. 40 V peak maximum.

#### OUTPUT SIGNAL CONNECTORS

**Cal Out** — −30 dBm, ±0.3 dB at 50 MHz, ±0.01%.
**1st Lo Out, 2nd Lo Out, Swp Out and Video Output**

#### ENVIRONMENTAL CHARACTERISTICS

The 7L14 meets its electrical characteristics over the environmental limits per MIL-T-28800 Type 3 Class 6, Style E instruments. The 7L14 is operable over the limits of a MIL-T-28800 Class 5 instrument. The 7L14 is physically and electrically compatible with all Tektronix 7000 Series mainframes.

#### CHARACTERISTICS 7L14 OPTION 39

Option 39 extends the 7L14's frequency range from 1 kHz to 2.5 GHz.

#### FREQUENCY

**Range** — 1 kHz to 2.5 GHz.
**Center Frequency Accuracy** — ±(5 MHz +0.5% of center frequency +20% of span/div setting).

#### AMPLITUDE

**Display Flatness** — ±1.5 for 10 kHz to 1.8 GHz, with respect to 50 MHz, +1.5, −2.5 for 1.8 GHz to 2.5 GHZ.
**Spurious Responses**
Residual: ≤−95 dBm to 2.5 MHz. ≤−100 dBm for 2.5 MHz to 1.8 GHz. ≤−60 dBm for 1.8 GHz to 2.5 GHz. Intermodulation Distortion: Third order down 70 dB or more from two −30 dBm signals within any frequency span. Second order down 70 dB or more from two −40 dBm signals. IF Feedthrough: At least 15 dB down at 2.095 GHz input. Images: At least 10 dB down at 4.095 GHz to 6.795 GHz.

#### INCLUDED ACCESSORIES

Spectrum Analyzer Graticule. 6 ft 50 Ω coaxial cable with BNC connectors (012-0113-00); BNC male to female adaptor (103-0058-00); amber light filter (378-0684-01); light filter (378-0625-07); clear plastic implosion shield with Log, Lin, Ref, and F (frequency) direction markings (337-1439-01) for 7603 Oscilloscope and (337-1159-02) for other 7000 Series oscilloscopes, instruction manual.

### ORDERING INFORMATION

**7L14** Spectrum Analyzer ..... **$18,060**
**Option 23** — Deletes input limiter ..... **$50**
**Option 39** — 1 kHz to 2.5 GHz Extended Frequency Range ..... **+$500**
**7603** Mainframe (shown on page 212) ..... **$2,955**
**R7603** Mainframe (Rackmount) ..... **$3,385**

#### MAINFRAME OPTIONS

**Option 06** — Internal Spectrum Analyzer Graticule ..... **+$50**
**Option 08** — Protective front cover (cabinet only) ..... **+$100**
**Option 77** — GM (P7) Phosphor and Internal Spectrum Analyzer Graticule ..... **+$100**

**Tektronix offers service training classes on the 7L14 Spectrum Analyzer. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.**

# 7L12

## Automatic Phase Lock

## Swept Frequency Measurements with the TR 502

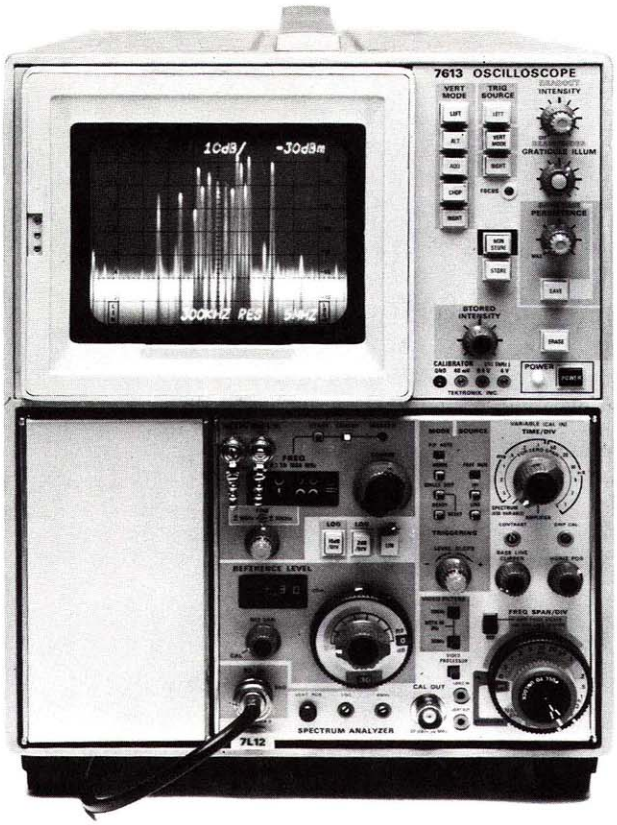
The 7L12 is a popular instrument in applications not requiring the resolution, low-end coverage, and digital storage of the 7L14. Resolution bandwidth can be varied from 300 Hz to 3 MHz, with −115 dBm sensitivity at 300 Hz. Automatic phase lock results in good stability; residual FM is ≤200 Hz peak-to-peak.

The 7L12 meets the measurement requirements of many AM, FM, two-way radio and other communications systems.

The 7L12 has a 70 dB spurious-free display dynamic range; low level noise measurements are made accurately, easily.

Ease-of-use features include fully-calibrated displays, and CRT readout of all key parameters. Additional front-end protection is available with a dc block accessory. With its companion TR 502 Tracking Generator, the 7L12 handles swept frequency measurements from 100 kHz to 1.8 GHz. And because the 7L12 is only a "two-wide" plug-in you get time or frequency displays by adding a vertical amplifier plug-in. Choose the 7L12 for economical high-performance in VHF/UHF bands.

Also, by ordering Option 39 you can extend the 7L12's frequency range from 100 kHz to 2.5 GHz. This is useful for satellite communications measurements, on multipoint distribution systems and other terrestrial microwave applications.




*7L12 with 016-0155-00 Blank Panel in 7613 Option 06 Variable Persistence Mainframe with internal spectrum analyzer graticule.*

## CHARACTERISTICS

The following characteristics and features apply to the 7L12 Spectrum Analyzer after a warm up period of 40 minutes.

### FREQUENCY RELATED

**Center Frequency Range** — 100 kHz to 1.8 GHz.
**Readout Accuracy** — ±(8 MHz +1% of dial readout).
**Frequency Span** — 500 Hz/div to 100 MHz/div in calibrated steps in 1-2-5 sequence.
**Accuracy** — Within 5% over center 8 div.
**Linearity** — Within 5% over center 8 div.
**Maximum Span** — Provides 1.8 GHz of span.
**Zero Span** — Provides fixed frequency operation for time domain display.
**Resolution Bandwidth**
**Range** — 300 Hz to 3 MHz, in decade steps.
**Accuracy (6 dB Down)** — Within ±20% of the resolution selected.
**Shape Factor (60/6 dB)** — 4:1 or less.
**Signal Level Change Over the Five Bandwidths** — <0.5 dB at 20°C.
**Residual FM** — 200 Hz (p-p) when phase locked. 20 kHz (p-p) maximum in 5 seconds when not phase locked.
**Stability** — At a fixed temperature after two hour warm up; within 50 kHz/hour phase locked; within 100 kHz/hour not phase locked.

### AMPLITUDE RELATED

**Display Modes**
**Log 10 dB/Div** — Provides 70 dB display dynamic range.
**Accuracy** — Within 1 dB/10 dB to 1.7 dB maximum over 70 dB display dynamic range.
**Log 2 dB/Div** — Provides 14 dB display dynamic range.
**Accuracy** — Within ±0.4 dB/2 dB to 1.0 dB maximum over 14 dB display dynamic range.
**LIN** — Within 8% over 8 center div. Deviation between display modes ±2 dB from 2 dB/div to 10 dB/div, 0.5 div from 2 dB/div to LIN.
**Reference Level** — +30 dBm to −100 dBm in 10 dB steps.
**Display Flatness** — ±1.7 dB over any selected frequency span, with respect to the display level at 50 MHz.
**Sensitivity for a cw Signal** — The following sensitivity characteristics apply at 50 MHz. Sensitivity may decrease 2 dB at 1.7 GHz and to 4 dB at 1.8 GHz.

| Resolution Bandwidth | Averaged Noise Level |
|---|---|
| 300 Hz | −115 dBm |
| 3 kHz | −108 dBm |
| 30 kHz | −100 dBm |
| 300 kHz | −90 dBm |
| 3 MHz | −80 dBm |

### SPURIOUS RESPONSES

**Residual** — <−99 dBm (referenced to the 1st mixer input).
**Second Order Intermodulation Products** — Down 70 dB or more from two −40 dBm signals, within any frequency span.
**Third Order Intermodulation Products** — Down 70 dB or more from two −30 dBm signals, within any frequency span.
**RF Attenuator** — 60 dB range in 10 dB steps.
**Accuracy** — ±.25 dB or 1.2% of dB reading; whichever is greater.
**IF Gain** — Range: 70 dB.
**Step Accuracy** — ±1 dB/10 dB step to ±1.5 dB maximum over entire range.

### GENERAL CHARACTERISTICS

**Sweep Time** — 10 ms/div (Spectrum position) to 1 μs/div are provided in 1-2-5 sequence. A Variable control provides continuous variation between steps. Accuracy within 5%.
**Triggering Modes** — (P-P) Auto, Norm, Single Sweep.
**Sensitivity** — ≤0.5 div for the (p-p) Auto mode, ≤0.3 div for the Norm mode, ≤1.5 div for the Single Sweep mode.
**Input Signal Connectors**
**RF Input**
**Maximum Input Power Level Linear Operation** — RF Attenuator at 0 dB: −30 dBm.
**Safe Input Levels** — RF attenuator at 0 dB: +13 dBm. RF: Attenuator at 60 dB: +30 dBm (1 W average, 100 W peak).
**Input Impedance** — 50 Ω.
**Horizontal Input** — Requires a 10 V ±1 V signal.
**Output Signal Connectors**
**Cal Out** — −30 dBm, ±0.3 dB at 50 MHz, ±0.01%.
**1st LO Out, 2nd LO Out, Vert Out**
**Shipping Weight** — 7.6 kg (17 lb).

### CHARACTERISTICS
### 7L12 OPTION 39

Option 39 extends the 7L12's frequency range from 100 kHz to 2.5 GHz.

### FREQUENCY

**Range** — 100 kHz to 2.5 GHz (Usable below 100 kHz with degraded performance).
**Center Frequency Accuracy** — ±(8 MHz + 1% of dial indication).

### AMPLITUDE

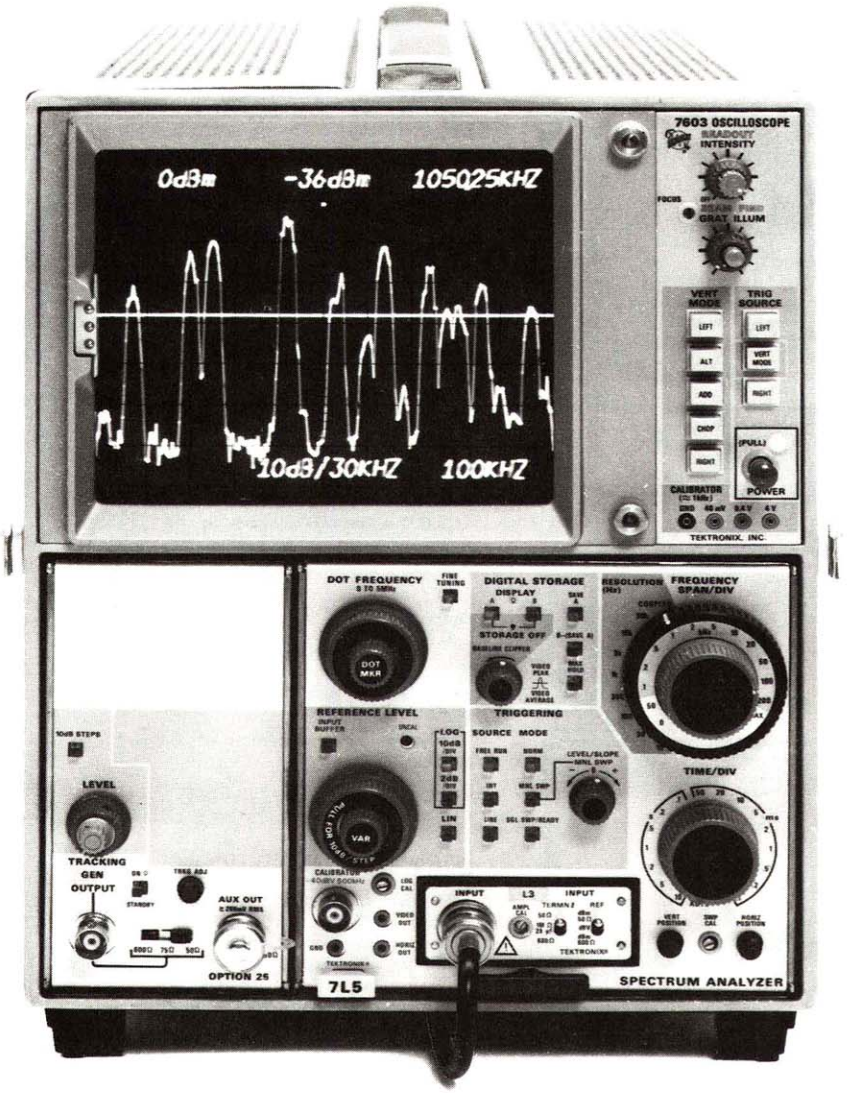
**Display Flatness** — ±1.7 dB for 100 kHz to 1.8 GHz. ±2 dB for 1.8 GHz to 2.5 GHz.
**Spurious Responses**
Residual: ≤−95 dBm to 2.5 MHz. ≤−99 dBm for 2.5 MHz to 1.8 GHz. ≤−60 dBm for 1.8 GHz to 2.5 GHz. Intermodulation Distortion: Third order down 70 dB or more from two −30 dBm signals within any frequency span. Second order down 70 dB or more from two −40 dBm signals. IF Feedthrough: At least 15 dB down at 2.095 GHz input. Images: At least 10 dB down at 4.095 GHz to 6.795 GHz.

### INCLUDED ACCESSORIES

Spectrum Analyzer Graticule. Clear plastic implosion shield with LOG, LIN, REF, and f (frequency) direction markings: (337-1439-01) for 7403N and 7603 Oscilloscopes, and (337-1159-02) for other 7000 Series oscilloscopes. Amber light filter (378-0684-01); light filter (378-0625-07); 6 foot 50 Ω coaxial cable with BNC connectors (012-0113-00); BNC Male to N Female adaptor (103-0058-00); instruction manual.

## ORDERING INFORMATION

**7L12** Spectrum Analyzer ..... **$10,960**
**Option 39** — 100 kHz to 2.5 GHz Extended Frequency Range ..... **+$500**
**7613** Variable Persistence Mainframe **$5,660**
**R7613** Variable Persistence Mainframe (Rackmount) ..... **$6,110**
**Option 06** — Internal S A Graticule ..... **+$50**
**Option 08** — Protective front cover (cabinet only) ..... **+$100**
**7603** Mainframe ..... **$2,955**
**R7603** Mainframe (Rackmount) ..... **$3,385**
**Option 06** — Internal S A Graticule ..... **+$50**
**Option 08** — Protective front cover (cabinet only) ..... **+$100**
**Option 77** — GM (P7) Phosphor and Internal Spectrum Analyzer Graticule ..... **+$100**
**7K11** CATV Preamplifier (page 215) ... **$1,100**
**Blank Plug-In Panel** Order 016-0155-00 ..... **$50**




*7L5 Option 25 Spectrum Analyzer with L3 plug-in module in a 7603 Option 06 mainframe with internal spectrum analyzer graticule*

Probe-compatible plug-in input modules provide a variety of impedances for the 7L5. The L3 may be switch-selected to 50 Ω, 600 Ω or 1 MΩ. The L3 Option 01 is switch-selectable to 75 Ω, 600 Ω or 1 MΩ.



## 7L5

**Digital Storage and Averaging**

**Synthesizer Tuning**

**Three-Knob Operation**

**Swept Frequency Measurements with Option 25**

**Preset Reference Level and Dot Frequency for Extra Input Protection**

**Selectable Input Impedance**

**Reference Level Selection in 1 dB and 10 dB Steps**

**Absolute Calibration in dBm, dBV, or Volts/Div**

The Tektronix 7L5 provides easy-to-use low-frequency measurement capability. The 7L5 can cover 20 Hz to 5 MHz in one display. Resolution bandwidth can be varied from 10 Hz to 30 kHz, with residual FM of no more than 1 Hz peak-to-peak. Comparing baseband channel performance is easy because the 7L5 switches from a single channel to a 60-channel supergroup without retuning. You see all channel amplitudes at a glance, side-by-side.

Digital storage proves particularly useful in the 7L5. With digital averaging and peak detection, you can accurately measure low level signals, such as intermodulation distortion products, in the presence of noise. With Max Hold, you can capture short duration signals and random transient phenomena that would otherwise be lost.

The 7L5 combines high performance with easy-to-use three-knob operation —
1) Set frequency span
2) Set center frequency
3) Set reference level...and measure!
Sweep speed and resolution bandwidth are set automatically.

Digital tuning and synthesizer stability let you set center frequency with six-digit accuracy immediately upon turn-on. Reference level can be set in 1 dB and 10 dB steps, eliminating the need to interpolate amplitude levels. And for measuring wide relative amplitude differences, the 7L5 offers 80 dB spurious-free display dynamic range.

The 7L5 makes accurate baseband communications measurements such as noise, spurious response, distortion, and transient interference, all with the certainty of 10 Hz resolution. The 7L5 Option 25 provides swept frequency measurements from 20 Hz to 5 MHz. The tracking generator is built into a "three-wide" 7L5 plug-in analyzer.

This highly capable audio/baseband analyzer finds a place in many areas of use, including measurement of communications system basebands, power line distortion, EMC/RFI, and computer systems.

## CHARACTERISTICS

The following characteristics and features apply to the 7L5 Spectrum Analyzer after a warm-up period of 10 minutes.

### FREQUENCY RELATED

**Center Frequency**

**Range** — Input frequency range is 20 Hz through 5.0 MHz. Dot frequency range is 0 Hz through 4999.75 kHz tuned in 10 kHz or 250 Hz steps.

**Accuracy** — 0°C to 50°C: ±(20 Hz + $10^{-5}$ of dot frequency). 20°C to 30°C: ±(5 Hz + 2 x $10^{-6}$ of dot frequency).

**Frequency Span** — 50 Hz/div to 500 kHz/div (maximum) in a 1-2-5 sequence.

**Accuracy** — Within 5%.

**Linearity** — Within 5% over the center 8 divisions.

**Zero Span** — Provides fixed frequency operation for time domain display.

**Resolution Bandwidth**

**Range** — 10 Hz to 30 kHz in 8 steps. Coupled position electronically couples resolution to span/div selection so that both are controlled by the same knob.

**Accuracy (6 dB Down)** — Within 20% of resolution selected (30 Hz to 30 kHz). 10 Hz is 100 Hz ±20 Hz 70 dB down.

**Shape Factor (60/6 dB)** — 10:1 or better for 10 Hz to 1 kHz and 5:1 or better for 3 kHz to 30 kHz.

**Signal Level Change Between Any Two Bandwidths** — 30 kHz to 100 Hz: ≤0.5 dB. 30 kHz to 10 Hz: ≤2.0 dB.

**Residual FM** — ≤1 Hz (p-p) for frequency span of 50 Hz/div to 2 kHz/div. ≤40 Hz (p-p) for frequency span of 5 kHz/div to 500 kHz/div.

**Stability** — ≤5 Hz/hour.

### AMPLITUDE RELATED

**Display Modes**

**Log 10 dB/Div** — Provides 80 dB display dynamic range.

**Accuracy** — Within 0.08 dB/dB to 2 dB maximum over 80 dB display dynamic range.

**Log 2 dB/Div** — Provides 16 dB display dynamic range.

**Accuracy** — Within 0.15 dB/dB to 1 dB maximum over 16 dB display dynamic range.

**LIN** — 20 nV/div to 200 mV div in a 1-2-5 sequence.

**Accuracy** — Within 5%.

**Reference Level** — +21 dBm to −128 dBm (50 Ω or 75 Ω input impedance), +10 dBm to −139 dBm (600 Ω input impedance), +8 dBV to −141 dBV (1 MΩ input impedance). Calibrated in 1 dB and 10 dB steps.

**Display Flatness** — 0.7 dB maximum from 20 Hz to 5 MHz, (add 0.5% quantization error in digital storage).

**Sensitivity** — Equivalent input noise for each resolution bandwidth setting is measured in video average mode with 10 s/div sweep rate and input buffer control off. Sensitivity is degraded an additional 8 dB when the input buffer is on.

| Resolution Bandwidth | Averaged Noise Level |
|---|---|
| 10 Hz | −148 dBV |
| 30 Hz | −146 dBV |
| 100 Hz | −143 dBV |
| 300 Hz | −138 dBV |
| 1 kHz | −133 dBV |
| 3 kHz | −128 dBV |
| 10 kHz | −123 dBV |
| 30 kHz | −118 dBV |

**Spurious Responses**

**Residual** — ≤−143 dBV (noncalibrator related, referenced to the input).

**Intermodulation Products** — Within any frequency span for two on screen signals of any input level, third order down 75 dB or more and second order down 72 dB or more; of any input level up to −53 dBV or of any input level with input buffer on, second and third order down 80 dB or more.

### GENERAL CHARACTERISTICS

**Sweep** — Triggered, manual, auto.

**Sweep Time** — 10 s/div to 0.1 ms/div in a 1-2-5 sequence.

**Accuracy** — Within 5% of selected time/div.

**Triggering** — Sources are free run, internal and line. Modes are normal, manual sweep and single sweep.

**Sensitivity** — ≥1.5 div of internal signal for both normal and single sweep modes over the approximate frequency range of 30 Hz to 500 kHz.

**Shipping Weight** — 7.6 kg (17 lb).

### INPUT SIGNAL CONNECTORS

### MAXIMUM INPUT POWER LEVEL

**1 MΩ/28 pF** — 15 V (p-p) for ac or pulse signals with risetimes of 2 V/μs or faster (pulses or ac beyond this specification may open an input fuse). 40 V (dc plus peak ac) for signals with risetimes slower than 2 V/μs.

**600 Ω (Internally Terminated)** — 12 V dc or RMS (+24 dBm).

**50 Ω (Internally Terminated)** — 3.5 V dc or RMS (+24 dBm).

**Input Impedance** — Switch selectable 1 MΩ in parallel with 28 pF, 50 Ω (75 Ω for L3 Option 01) termination, or 600 Ω termination.

### OUTPUT SIGNAL CHARACTERISTICS

**Calibration** — 500 kHz squarewave within ±0.15 dB of −40 dBV into the plug-in impedance.

**Video Out** — 50 mV/div ±5% (about the CRT center) with source impedance of 1 kΩ.

**Horizontal Out** — 0 V dc to about −6 V dc sawtooth with a source impedance of 5 kΩ.

## Option 25 Tracking Generator

The 7L5 with Option 25 Tracking Generator, provides selectable 50 Ω, 75 Ω, or 600 Ω impedance source that has a calibrated output level for swept frequency tests from 20 Hz to 5.0 MHz. The output frequency can be adjusted so it tracks within 10 Hz of the spectrum analyzer frequency. The frequency span and rates are controlled with the spectrum analyzer. The output level is controlled from the tracking generator. Output level is calibrated and controlled in 10 dB and 1 dB steps over a 63 dB range. An Aux Output may be used to drive a frequency counter. The 7L5 with Option 25 is a three-wide unit for the 7000 Series mainframes.

### CHARACTERISTICS

**Frequency Range** — 20 Hz to 5.0 MHz.

**Output Impedance** — 50 Ω, 75 Ω, or 600 Ω selected by a front panel switch.

**Amplitude** — The output level is calibrated in dBm or dBV and selectable in 10 dB or 1 dB steps. A vernier provides continuous variation between calibrated steps.

**Range** — 50 Ω: 0 dBm to −63 dBm. 75 Ω: −6 dBm to −69 dBm. 600 Ω: −17 dBm to −80 dBm.

**Accuracy (Maximum Output Calibrated at 500 kHz)** — 50 Ω: 0 dBm ±0.25 dB. 75 Ω: −6 dBm + 0.4, −0.2 dB. 600 Ω: −17 dBm +0.5, −0.1 dB.

**Attenuator** — Range: 0 dB to 63 dB in 10 dB or 1 dB steps. Accuracy: Within 0.2 dB/dB to a maximum of 0.25 dB/10 dB absolute.

**Flatness** — 50 Ω and 75 Ω: Within 0.5 dB p-p. 600 Ω: Within 1.0 dB p-p. Total System Flatness (7L5 with L3 Plug-in Module and Option 25) 50 Ω and 75 Ω: Within 1.0 dB p-p. 600 Ω: Within 1.25 dB p-p.

**Dynamic Range (7L5 with Option 25)** — ≥110 dB.

**Residual FM (p-p)** — Spans to 2 kHz/Div: 2 Hz (7L5 with Option 25). Spans 5 kHz/Div or Greater: 40 Hz (7L5 with Option 25).

**Stability** — 25 Hz/5 minutes after 10 minute warm-up decreasing to 25 Hz/hour maximum after 1 hour.

**Spurious Suppression, 20 Hz to 5.0 MHz (Harmonic and Nonharmonic)** — 40 dB or more with respect to the carrier.

**Auxiliary Output** — ≥200 mV RMS into 50 Ω.

### INCLUDED ACCESSORIES

Spectrum Analyzer Graticule (337-1159-00); (7000 Series), and (337-1439-01); (7603), light blue filter (378-0684-00); operators manual; service manual.

## ORDERING INFORMATION

**7L5** Spectrum Analyzer (Requires L3 Plug-in Module) ..... **$11,070**

**Option 11** — L3 Plug-in Module Option 01 shipped with 7L5 ..... **+$1,580**

**Option 12** — 7854 Waveform Oscilloscope compatibility ..... **+$150**

**Option 20** — L3 Plug-in Module shipped with 7L5 .. **+$1,580**

**Option 25** — Tracking Generator ..... **+$1,560**

For a separate tracking generator (one-wide field modification to be attached to an existing 7L5). Order 040-0810-00 . **$1,850**

**L3** Plug-in Module (1 MΩ, 50 Ω, 600 Ω) **$1,580**

**Option 01** — L3 Plug-in Module (1 MΩ, 75 Ω, 600 Ω) ..... **NC**

**7603** Mainframe ..... **$2,955**

**R7603** Mainframe (Rackmount) ..... **$3,385**

**Option 06** — Internal S A Graticule ..... **+$50**

**Option 08** — Protective front cover (cabinet only) ..... **+$100**

**Option 77** — GM (P7) Phosphor and Internal SA Graticule ..... **+$100**

**7704A***1 Oscilloscope ..... **$4,660**

**R7704***1 Oscilloscope ..... **$7,895**

**1 Suggested mainframe. See 7000 Series pages for oscilloscope specifications and options.*

### OPTIONAL ACCESSORIES

**Tracking Generator** — One-wide field modification kit, to be attached to an existing 7L5. Order 040-0810-00 ..... **$1,850**

**75 Ω to 50 Ω Minimum Loss Attenuator** — (Ac coupled). Order 011-0112-00 ..... **$60**

**P6105 10X Probe** — (2 m) Order 010-6105-03 ..... **$110**

### BALANCED INPUT TRANSFORMER

**Frequency Range** — 50 kHz to 3 MHz, usable from 10 kHz to 20 MHz.

**Flatness** — 0.25 dB p-p maximum (50 kHz to 3 MHz) including nominal 0.1 dB insertion loss.

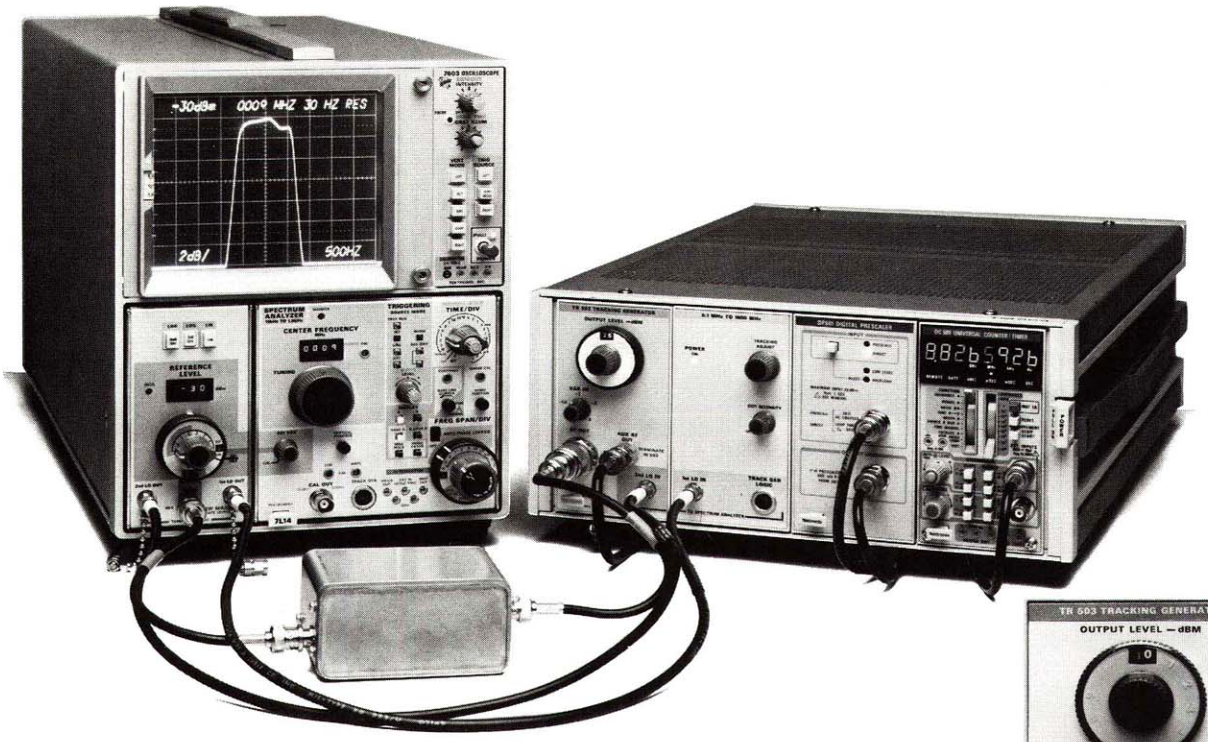
**Common-Mode Rejection** — 25 dB minimum (50 kHz to 3 MHz).

**Output Termination** — Switchable between 124 Ω, 135 Ω, and None for bridging or external termination.

**Connectors** — WECO (0.37 in with 0.090 center) on 0.625 in spacing for balanced input. BNC for single-ended output.

**Balanced Input Transformer** Order 013-0182-00 ..... **$285**

**Tektronix offers service training classes on the 7L5 Spectrum Analyzer. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.**



*For swept frequency tests and precise frequency measurements, the TR 502 Tracking Generator may be used with a DP 501 Digital Prescaler and DC 509 Option 01 Digital Counter, in a TM 504 Power Module. The TR 502 is linked to the 1st and 2nd LO of a 7L14 Spectrum Analyzer in a 7603 mainframe.*

## TR 502/TR 503 Tracking Generators

### Swept Frequency Measurements to 1.8 GHz

The TR 502 works with the 7L12 and 7L14 and the TR 503 works with all 490 Series spectrum analyzers to provide constant level, calibrated RF sources for swept frequency tests to 1.8 GHz.

The low residual FM of these systems enhances narrow bandwidth frequency response measurements. When used as a cw signal source with the analyzer in a manual mode, these systems have excellent frequency stability.

The tracking generators are two-wide units compatible with the TM 500 Modular Instrument Series.

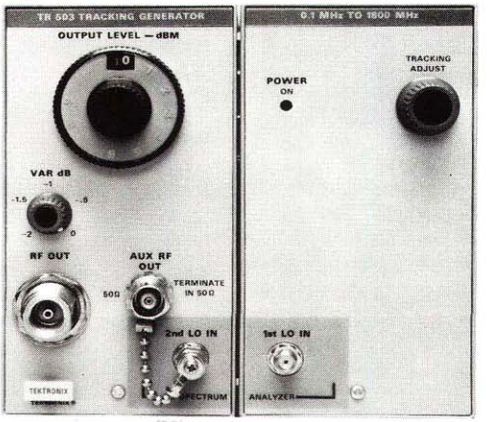
The TR 502/TR 503 Aux RF Output may be used to drive a frequency counter. Frequencies up to 1.8 GHz may be measured accurately in the presence of high level adjacent signals to the sensitivity limits of the analyzer.

The tracking generator sweep rates are controlled with the spectrum analyzer, and the output level is controlled from the tracking generator. The output frequency of the tracking generator is the same as the frequency of the analyzer at any instant of the sweep.

Dot marker frequency measurement capability may be obtained with the TR 502/7L14 Spectrum Analyzer. For more information concerning the dot marker capability, contact your local Tektronix sales engineer.

### CHARACTERISTICS

| | TR 503/All 490 Series | TR 502/7L14 | TR 502/7L12 |
|---|---|---|---|
| **Frequency Range** | 100 kHz −1.8 GHz | 100 kHz −1.8 GHz | 100 kHz −1.8 GHz |
| **Output Level** | (Maximum) 0 dBm ±0.5 dB | 0 dBm ±0.5 dB | 0 dBm ±0.5 dB |
| **Range** | 0 to −59 dB in 10 dB and 1 dB steps | 0 to −59 dB in 10 dB and 1 dB steps | 0 to −59 dB in 10 dB and 1 dB steps |
| **Flatness** | Within ±2.25 dB Max from 100 kHz to 1.8 GHz (Typically ±1.5 dB) | Within ±2 dB maximum from 100 kHz to 1.8 GHz (Typically ±1.5 dB) | Within ±3.0 dB maximum from 100 kHz to 1.8 GHz (Typically ±2.0 dB) |
| **Dynamic Range** | ⩾110 dB | ⩾110 dB | ⩾100 dB |
| **Residual FM** | 50 Hz p-p | 13 Hz p-p | 200 Hz p-p |
| **Output Impedance** | 50 Ω Nominal, VSWR 2:1 or less to 1.8 GHz | 50 Ω nominal, VSWR 2:1 or less to 1.8 GHz | 50 Ω nominal, VSWR 2:1 or less to 1.8 GHz |
| **Auxiliary Output** | 0.1 V into 50 Ω load −7 dBm minimum | 0.1 V RMS into 50 Ω Load | 0.1 V RMS into 50 Ω Load |
| **Spurious Signoff** | Harmonic: −20 dBc Nonharmonic: −40 dBc | Harmonic: 20 dBc Nonharmonic: 40 dBc | Harmonic: 20 dBc Nonharmonic: 40 dBc |




**OUTPUT CONNECTORS**

**RF Out** — 0 dBm to −61 dBm signal source that tracks input frequency of spectrum analyzer. Output level is set by Output Level control and Var dB control.

**Aux RF Out** — For use with frequency counter.

**INCLUDED ACCESSORIES**

TR 502: Two 50 Ω coaxial cables (012-0649-00); logic interface cable (012-0648-00); N male to BNC female adaptor (103-0045-00); retainer plug-in (343-0604-00); 3 mm male to BNC female adaptor (015-1018-00); instruction manual.

TR 503: Two 28.5 inch 50 Ω coaxial cables (012-0649-00); N male to BNC female adaptor (103-0045-00); retainer plug-in (343-0604-00); instruction manual.

### ORDERING INFORMATION

**TR 502** Tracking Generator ..... **$6,620**

**SUGGESTED COMPLEMENTARY ITEMS**

**TM 504** — Power Module ..... **$450**

**DP 501** — Digital Prescaler ..... **$525**

**DC 509 Option 01** — Digital Counter with high stability time base ..... **$2,365**

**Blank Panel** — Order 016-0195-03 ..... **$25**

**10 dB, 3 mm Attenuator** — Used in the 2nd LO input line to improve TR 502/7L12 Isolation. Order 307-0553-00 ..... **$40**

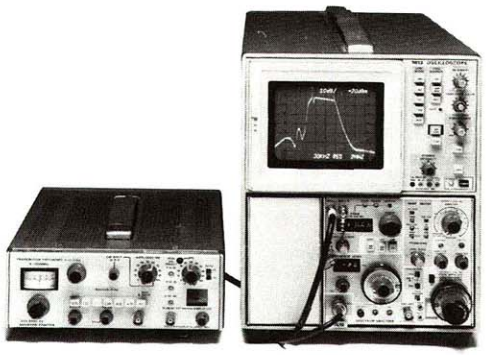
**TR 503** Tracking Generator ..... **$6,620**

**SUGGESTED COMPLEMENTARY ITEMS**

**TM 503** — Power Module ..... **$350**

**DC 509 Option 01** — Digital Counter with high stability time base ..... **+$2,365**

**Blank Panel** — Order 016-0195-03 ..... **$25**



*1405/7L12 TV Sideband Analyzer System*

## 1405 TV Sideband Adaptor

**Response of Transmitter Under Test Within ±0.2 dB**

**Frequency Response of RF and IF Circuits for Transmitters with Frequency to 1 GHz**

**Video Circuits Can Be Swept**

**For In-Service Testing, Use of External Blanking Allows Either Full-Field or Single-Line Operation**

**Check Aural Fm Deviation with Built-In Bessel Null Technique**

**Flexible Marker System Will Accept Standard Crystals**

To analyze the sideband response of a television transmitter, the 1405 Sideband Adaptor is recommended for use in tandem with the Tektronix 7L12, 7L14, and all 490 Series spectrum analyzers. It generates a composite video signal, which is applied as modulation to a television transmitter. The output is displayed on the spectrum analyzer and appears as a response curve, to within ±0.2 dB, of the transmitter being tested.

The 1405/Spectrum Analyzer combination will display frequency-response characteristics of RF and IF circuits for transmitters with frequencies to 1 GHz. Video circuits can also be analyzed.

Option 02 provides the correct frequencies at the TV Channel marks on the dial readout so that it is ready for use with the 490 Series spectrum analyzers when shipped from the factory.

### CHARACTERISTICS

The following characteristics apply to the 1405, 1405/7L12 or 7L14 combination and 1405/490 Series combination. They are applicable over the environmental specification limits for the 1405 and 7000 Series mainframes.

#### FREQUENCY (FREQUENCY OFFSET)

**Range** — Will tune and provide a swept video output for a center frequency range of 0 GHz to 1 GHz.

**Frequency Dial Accuracy** — Dial reading is within 10 MHz of transmitter frequency when properly tuned.

**Fine Tuning Range** — From ±0.5 MHz to ±1.25 MHz, depending upon transmitter frequency setting.

**Tuned Frequency Drift** — <1 MHz/hour after a 30 minute warm-up.

#### OUTPUT SIGNAL LEVEL

**Amplitude (Sync Off)** — 100 IRE equals 0.714 V p-p when terminated in 75 Ω.

**Output Impedance** — 75 Ω ±1% at 100 IRE and ±2% from 0 IRE to 90 IRE.

**Variable** — 0 IRE to 100 IRE in 10 IRE steps.

**Accuracy (at 200 kHz)** — ±1 IRE at 100 IRE; ±2 IRE from 10 IRE to 90 IRE.

**Output Level During Blanking** — 0 V ±0.01 V at 0 IRE; 0 V ±0.04 V at 100 IRE from 0 MHz to 1 MHz; 0 V ±0.02 V at 100 IRE above 1 MHz.

**Cw Output Harmonics** — Third harmonic content down 40 dB from 0.1 MHz to 5 MHz; down 35 dB from 5 MHz to 10 MHz.

#### FLATNESS

**1405** — Within ±0.1 dB from 100 kHz to 10 MHz, within ±0.2 dB from 10 MHz to 15 MHz, within ±0.4 dB from 50 kHz to 20 MHz.

**1405 Plus 7L12, 7L14, All 490 Series**

For Transmitter Frequency >20 MHz: Within ±0.2 dB from 100 kHz to 10 MHz of picture carrier, increasing to ±0.3 dB at 15 MHz; within ±0.5 dB from 50 kHz to 20 MHz.

For Transmitter Frequency of 0 MHz to 20 MHz: Within ±0.5 dB from 100 kHz to 15 MHz.

**System Span** — ≥200 kHz/div.

**Video Frequency Range** — 15 MHz to 0 MHz to 15 MHz.

#### APL (AVERAGE PICTURE LEVEL)

**Variable** — 0 IRE to 100 IRE in 10 IRE steps.

**Accuracy** — ±2 IRE.

**Three Preset Levels** — Preset A: 0 IRE to 50 IRE. Preset B: 25 IRE to 75 IRE. Preset C: 50 IRE to 100 IRE.

**Horizontal Sync, Blanking, and Pedestal Duration** — Within NTSC (PAL — Option 01) limits (no vertical interval is provided). Transition time is 0.24 μs ±10%, from 10% to 90% points.

**Composite Sync Source Blanking** — 0 V turns cw on > −5 V turns cw off.

**Line Strobe** — TTL pulse from 0 V to 5 V turns cw on.

#### AURAL OUTPUT

**Output Frequency** — 10.396 kHz: ±0.01% (crystal controlled). Option 01: 9.058 kHz.

**Cw Output** — Amplitude variable up to ≥ +12 dBm into 600 Ω. Harmonics down 45 dB or more.

**Crystal Requirements** — Series Resonant: $R_2$ <2000 Ω; Q >5000; Case, HC/6U or HC/25U.

#### MARKER CRYSTAL INSTALLATION

Because of the various international standards, the 1405 Option 01*[1] is shipped with the marker crystals installed. Frequencies installed are 0.75 MHz, 1.25 MHz, 2.25 MHz, 4.43 MHz, 5.00 MHz, and 5.75 MHz. Additional crystals are shipped with the unit.

*[1] *Option 01 instruments are connected for a nominal power line voltage of 240 V. They are furnished with the standard North American plug unless Options A1, A2, A3, A4, or A5 is specified.*

### ORDERING INFORMATION

**1405** TV Sideband Adaptor 525/60 Markers ..... **$5,780**

**Option 01** — TV Sideband Adaptor (625/50 Markers) . **+$200**

**Option 02** — (Dial readout for Use with 490 Series) ..... **NC**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

**Option A5** — Switzerland 250 V/10 A, 50 Hz

#### OPTIONAL ACCESSORIES

**Rackmount-Conversion Kit** — For Mounting 1405 or 1405 Option 01 in standard 19 in rack. Order 016-0489-00 ... **$400**

## 7K11 CATV Preamplifier

**75 Ω Input Impedance and Calibration in dBmV**

**Extra Sensitivity for CATV and Field Intensity Measurements**

This 7000 Series plug-in preamplifier is for use with the 7L12 or 7L14 and tailored to CATV and field intensity measurement applications, where extra sensitivity is required for demanding measurements. The 7K11 handles 12 channels without overload.

The 7K11 provides a 75 Ω input impedance and calibration in dBmV. Its low noise figure makes it especially suitable for signal-to-noise and low-level radiation measurements.

### CHARACTERISTICS

(with 7L12 or 7L14)

**Frequency Range** — 30 MHz to 890 MHz.

**Display Flatness** — ±1.0 dB, with respect to the level at 50 MHz over the frequency range of 50 MHz to 300 MHz; increasing to +2.0 dB, −2.5 dB over the full frequency range.

**Sensitivity** — Signal + noise = 2X noise, in Lin mode at 50 MHz. −90 dBmV at 30 Hz, −80 dBmV at 300 Hz, −73 dBmV at 3 kHz, −65 dBmV at 30 kHz, −55 dBmV at 300 kHz, −45 dBmV at 3 MHz. Noise figure is ≤5 dB.

**Intermodulation Distortion** — Imd products and harmonics from two signals within the frequency range are 70 dB or more down from the reference level for third order intermodulation with two signals at the reference level (full screen).

**Reference Level** — Calibrated level in 1 dB steps from +79 dBmV to 0 dBmV. Accuracy is referenced to the +30 dBmV calibrator at 50 MHz.

**Input Impedance** — 75 Ω.

**Calibrator** — 50 MHz ±0.01% with an absolute amplitude level of +30 dBmV ±0.3 dB, from 75 Ω.

#### INCLUDED ACCESSORIES

5.5 inch BNC to BNC 50 Ω Cable (012-0214-00); BNC to F Adaptor (013-0126-00); 42 inch BNC to BNC 75 Ω Cable (012-0074-00); instruction manual.

### ORDERING INFORMATION

**7K11 CATV Preamplifier ..... $1,100**

## PADS AND ADAPTORS

**75 Ω to 50 Ω Minimum Loss Attenuator** with dc block, 5.7 dB loss. Order 011-0112-00 ..... **$60**

**75 Ω to 50 Ω Matching Attenuator** with 11.25 dB conversion factor from dBm to dBV with dc block. Order 011-0118-00 **$60**

**Fixed 10 dB Attenuator** with 3 mm fittings for use with TR 502 with 7L12. Order 307-0553-00 ..... **$85**

**Dc Block BNC to BNC** maximum dc potential 50 volts. Order 015-0221-00 ..... **$85**

**"F" Female to BNC Male Adaptor** Order 013-0126-00 .. **$16**

**BNC Female to "F" Male** Order 103-0158-00 ..... **$9.00**

**Calibrator Jumper** 50 Ω BNC to BNC 5.5 in. Order 012-0214-00 ..... **$40**

**Jumper Cable** BNC to BNC 50 Ω 42 in. Order 012-0057-01 ..... **$17**

**Jumper Cable** BNC to BNC 75 Ω, 42 in. Order 012-0074-00 ..... **$17.50**

**"N" Female to BNC Male** Order 103-0058-00 ..... **$7.00**

## PROTECTIVE VINYL COVERS

For extra protection in field environments, soft vinyl covers are available to fit over the entire cabinet model mainframe.

**7000 Series 3 Hole Mainframe Cover** — Order 016-0192-01 ..... **$20**

**7000 Series 4 Hole Mainframe Cover** — Order 016-0531-00 ..... **$15**

**5000 Series Mainframe Cover** Order 016-0544-00 ..... **$18**

## RIGID FRONT COVERS

Solid snap on or friction fit covers are available to protect the instruments in transit or field use.

See appropriate spectrum analyzer and mainframe ordering information regarding the Option 08 Protective Front Cover for 7603 and 7613.

**Protective Front Cover for existing 7603 or 7613 Mainframes:**

**Blue** Order 040-0835-00 ..... **$175**

**Gray** Order 040-0628-00 ..... **$175**

## GRATICULES, FILTERS

**Plastic Implosion Shield and S A Graticule** 7613 and 7623 Mainframes. Order 378-0625-07 ..... **$9.50**

**Plastic Implosion Shield and S A Graticule** 7403 and 7603 Mainframes. Order 337-1439-01 ..... **$8.00**

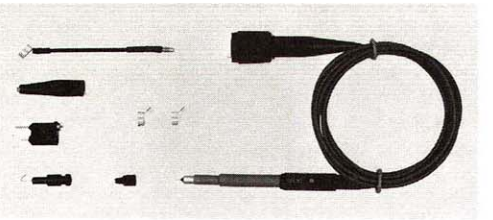
**Plastic Implosion Shield and S A Graticule** for all other 7000 Series mainframes. Order 337-1159-02 ..... **$8.00**

(Internal graticules are available with most 7000 Series mainframes).

**EMC Metal Screen Mesh Filter** for 7500, 7700, 7800, 7900 Series and 7613, 7623, 7633 instruments. Order 378-0603-00 ..... **$55**

**EMC Metal Screen Mesh Filter** for 7400 Series and 7603 instruments. Order 378-0696-00 ..... **$55**

Complete selection of colored filters is available in the accessories section.



## PROBES

A variety of probes is available in varying frequency and impedance ranges that can be used with the 7L5, 7L12, 7L14, all 490 Series spectrum analyzers.

**FET Probe P6201** to 900 MHz. Order 010-6201-01 ... **$1,210**

**FET Probe P6202A** to 500 MHz. Order 010-6202-03 ... **$675**

**Conventional Probe P6056** Dc to 3.5 GHz 6 ft. Order 010-6056-03 ..... **$185**

**Conventional Probe P6057** Dc to 1.4 GHz with adaptor. Order 010-6057-03 ..... **$190**

**Current Probe P6022** to 150 MHz. Order 015-0135-00 **$430**

Complete specifications are available in the probes and accessories section, page 437.

## CAMERAS

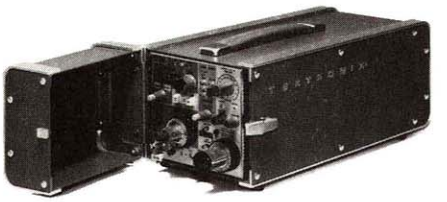
A camera can greatly enhance the versatility of a spectrum analyzer. Many different units are available. However, the most popular units for the 7000 and 490 Series spectrum analyzers are:

**Polaroid Film Pack C-59AP** ..... **$1,315**

**C-5C Camera** ..... **$495**

**C-4 Option 02 Camera** ..... **$370**

Complete specifications on all cameras are available in the camera section, page 421.



## CARRYING CASES AND MOUNTS

Specialized carrying cases are available in two forms to protect your spectrum analyzer.

Metal carrying cases are available for the 7L5, 7L12, 7L14 or 7L18 Plug-in units.

Military style fiberglass and foam type transit cases can be custom fitted to many of the instruments.

A special mounting bracket assembly can be fitted to bolt the analyzer securely into the mainframe if desired.

**Securing Kit** fits 7L12 or 7L14. Order 016-0637-00 ..... **$50**

**3-Wide Carrying Case** for 7L14, 7L5 Option 25, 7L18. Order 016-0626-00 ..... **$330**

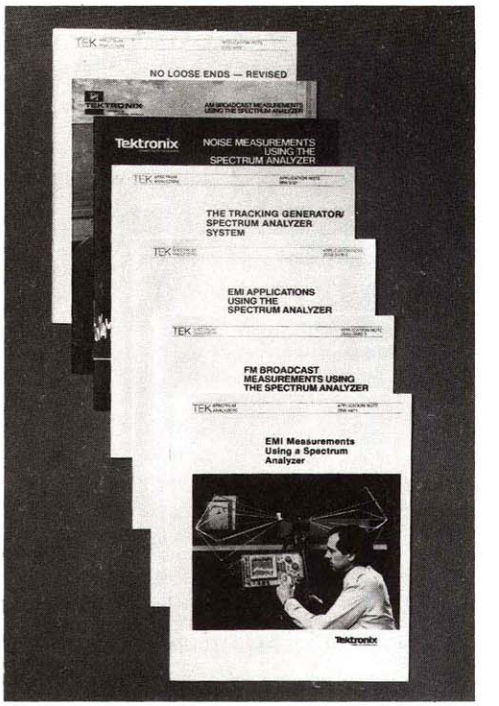
**2-Wide Carrying Case** for 7L12, 7L5. Order 016-0625-00 ..... **$290**

**Luggage-Type Carrying Case** for 7603 Option 08, 7613 Option 08. Order 016-0628-00 ..... **$530**
(Analyzer must have 016-0637-00 Securing Kit) ..... **$50**

**Hard Case** transit for the 490 Series.
Order 016-0658-00 ..... **$625**

**Soft Case** for the 490 Series. Order 016-0659-00 ..... **$125**

Your local Sales Office or representative can quote prices and availability on any of these accessories.

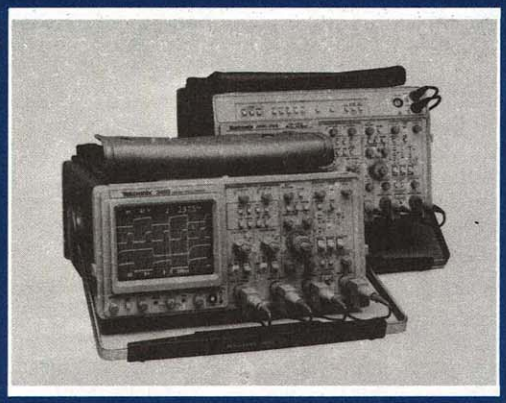


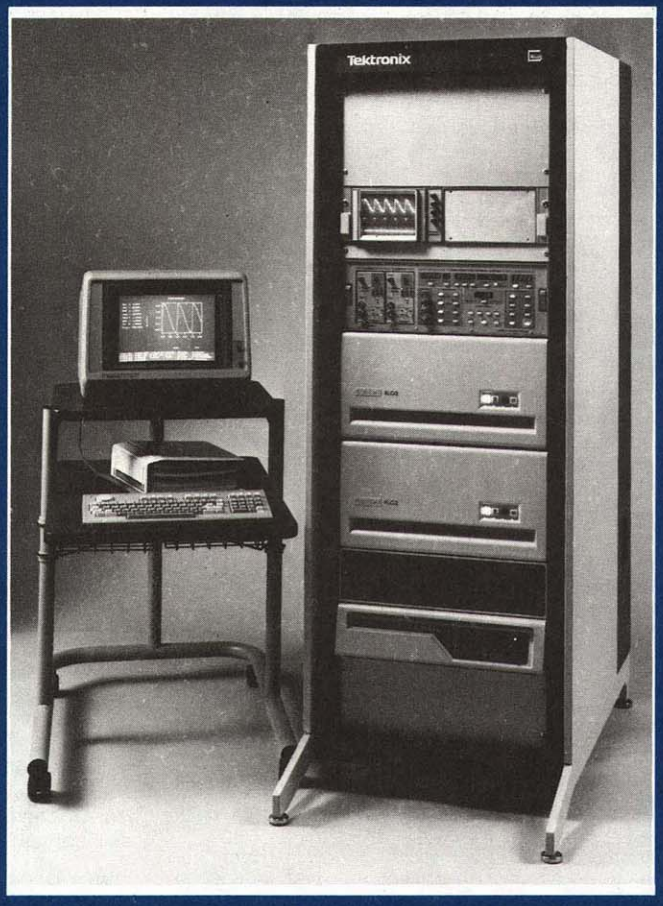

Numerous application notes and magazine article reprints on spectrum analyzer measurements are available. Notes on baseband, EMI, AM, FM, two-way radio and television measurements, audio amplifier testing, noise and pulse testing, and others have been written to help you with your measurements.

In addition, our staff of specialists stands ready to help you solve any special measurement problems. Contact your local Tektronix Sales Office or representative.

*Option 08 protective front cover is shown with 7613 mainframe.*

# INSTRUMENTS/SYSTEMS PRODUCTS



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Tektronix is pleased to present the world's broadest selection of portable and laboratory oscilloscopes, programmable and manual general-purpose instruments, waveform digitizing instruments and systems, and accessories to meet your instrumentation needs.

Some of the many products new to this catalog include the R7103 General Purpose Oscilloscope, Controller Based Acquisition/Processing Measurement Packages, Programmable Digitizer Measurement Packages, C-4 and C-7 Cameras, and the 1107 Dc Inverter. Three new dual trace oscilloscopes have been added to the 2200 Series and the 2400 Series has been expanded to include three special edition oscilloscopes and five new options: GPIB, Counter/Timer/Trigger with Word Recognizer, Video Waveform Measurement System, and DMM.

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Tektronix designs, manufactures, markets, supports, and services test and measurement products worldwide. Our test and measurement instruments and systems are used by scientists, engineers, and technicians in basic research, product design, manufacturing test, training, maintenance, and service applications in a broad range of industries and public institutions.

Products include:
— Fully-automated desktop-, controller and minicomputer-based acquisition/processing systems.
— The state-of-the-art laboratory 7000 Series plug-in instruments.
— The 5000 Series instruments, that continue the 7000 Series concept of flexibility and expandability with a line of plug-ins and mainframes for the cost-conscious user.
— A complete line of portable oscilloscopes that range from hand-held, battery-operated miniscopes to full-featured, high-performance instruments that have become the standards against which all other portables are measured.
— Two modular and compact product lines of general purpose instrumentation, including the cost-effective TM 500s and the GPIB-compatible and programmable TM 5000s.
— Curve tracers that acquire complete information about a multitude of semiconductor devices and integrated circuits and present it in a quickly comprehended display.
— A portable digital photometer/radiometer with eight interchangeable probes for measuring illuminance, irradiance, luminance, LED output, and relative intensity.
— Accessories, from cameras to isolation measurement devices, that support not only all Instruments products, but also many Tek Design Automation, Information Display, and Communication products.

## GPIB OSCILLOSCOPES

Tektronix has several oscilloscopes to choose from for GPIB capability. The 336, 468, 5223, 7854, and 2445/2465 Family with their respective GPIB features or options, give you an opportunity to improve the consistency of measurements and control costs. A GPIB system controller can consistently repeat a defined sequence of tests while the operator concentrates on the task instead of the tools. A system comprising a GPIB controller and programmable oscilloscope offers complete automation of many measurements.

The compact 336 simultaneously displays real-time and digitally stored waveforms. An auto mode allows "hands-off" operation in many applications. The portable 468 can be used with a tape drive to record waveform data on-site. The 10 MHz 5223 has a roll mode to provide a strip-chart-like view of signals at slow speed, the GPIB interface for I/O of stored waveforms and control of several digital storage functions. The 7854's keystroke programming of local keyboard and remote Waveform Calculator allows user-designed waveform measurement routines--with all mainframe keystroke functions and operating modes remotely controlled via the GPIB.

The 2445/2465 offers a Counter/Timer/Trigger option for automatically measuring frequency, period, pulse width, and time between events. Also, by combining the GPIB and Digital Multimeter options, this system can efficiently perform both waveform and steady state measurements. For a truly comprehensive measurement system, combine GPIB, Counter/-Timer/Trigger, and DMM options.

Software development won't overwhelm your program if you use the built-in "learn mode" of the 2445/2465 GPIB option to generate detailed setup instructions. With Tek EZ-Test software from Tektronix, your controller will do more for you while demanding less programming effort.

## MODULAR AND INTEGRATED INSTRUMENTS

There are two basic configurations for test and measurement instruments: modular and integrated. Modular instruments, also called "plug-in" or "laboratory" models, combine a mainframe and one or more interchangeable plug-in subassemblies. Integrated instruments (also called "monolithic") are one-piece units.

Although portable instruments are traditionally designed as integrated units, not all integrated instruments are portable, and some modular systems (such as scopes within the Tektronix TM 500 Instrument line) are designed for easy transport.

### Modular Design Advantages

Examples of modular design in Tektronix Instrument products include the 7000 Series, the 5000 Series, the TM 500 General Purpose Plug-ins and the TM 5000 programmable units.

Versatility is the prime advantage of a modular instrument. Many more functions than could be economically or practically combined in a single unit are available by choosing the right plug-ins. Plug-ins can also extend the original instrument's range of functions. Digital multimeters, curve tracers, spectrum analyzers, and logic analyzers are just a few examples of the many specialized plug-ins Tektronix offers for modular oscilloscope mainframes.

Performance is another advantage. In the case of the 7000 Series instrument, modularity gives you the maximum performance available in an oscilloscope. And modularity also allows you to upgrade your instruments to take advantage of advances in technology.

Often modular instruments can be very cost effective too, because within a given product line, they can be shared. For example the TM 500 test and calibration plug-ins used in the lab for design work can be inserted in a portable mainframe and easily carried to the site of a service problem. Or as another example, a few high-performance laboratory plug-ins from the 7000 Series can be shared among several 7000 Series mainframes.

Consider the versatility and performance advantages as you read about the wide range of Tektronix modular instruments: page 227 for the 7000 Series instruments, page 273 for 5000 Series instruments, page 353 for TM 5000 Programmable Instruments, and page 369 for TM 500 Test and Measurement Instruments.

**Integrated Design Advantages**

Integrated instruments are often optimized for a single range of functions. One-piece instrument design can provide reductions in weight, increased ease of use, smaller size, lower power requirements, and often, higher performance/price ratios for your key requirements.

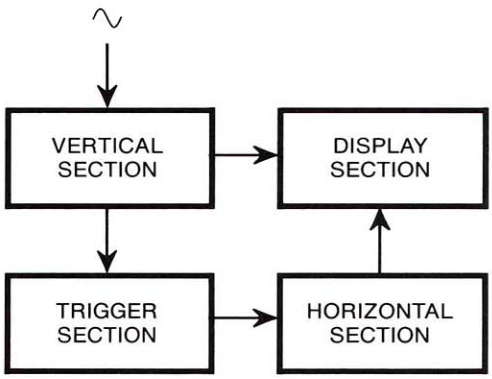
Portability can be essential for some test and measurement applications, and in these cases, an integrated design is often the best choice. Because a wide variety of options and optional accessories extend their ranges of applications, versatility can also be a feature of Tektronix integrated instruments.

Tektronix integrated scopes, either portable or rackmounted, are instruments where the design emphasis is often on the factors of economy, ruggedness, environmental protection, and internal or external battery power. See page 287.

## KEY OSCILLOSCOPE SPECIFICATIONS AND FEATURES

You should choose an oscilloscope by matching both performance and features to measurement applications. Don't choose by performance alone, because when features make measurements easier, the result is likely to be more accurate measurements. And if your applications involve repetitive measurements, features that make the measurement faster will be cost-effective.

The key oscilloscope specifications and features described below may help you make a decision.



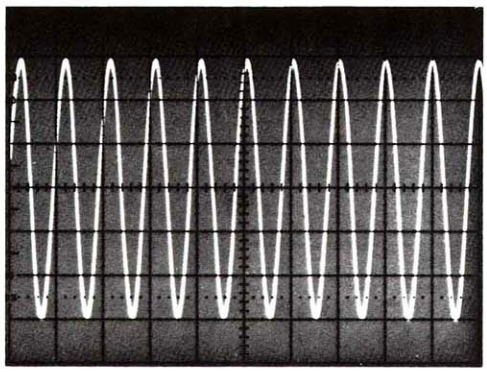

**Vertical System Considerations**

Because a faithful reproduction of the signal is necessary for measurement accuracy, and because very small signals must often be measured, the key specifications of the vertical system include bandwidth and sensitivity.

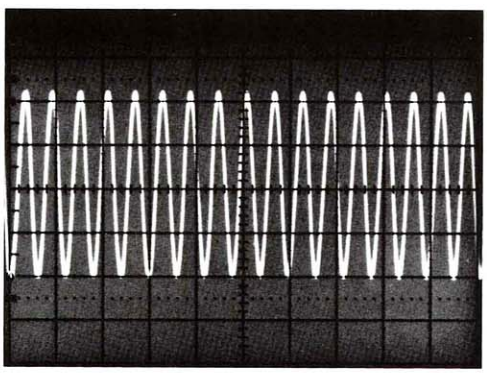
Depending on your applications, you might also want to consider oscilloscopes that display more than one signal at a time and those with differential or balanced inputs; these features are also described below.

**Bandwidth and Risetime**

Bandwidth is the range of frequencies that a scope can handle with less than a 3 dB loss in amplitude compared to midband performance. Since modern oscilloscopes work well at low frequencies down to dc, the bandwidth specification is commonly the highest frequency that can be displayed; dc as the lowest, is implied. The following figures illustrate bandwidth specifications.



*OdB: 6 div at 50 kHz*



*–3 dB: 4.2 div at 100 MHz*

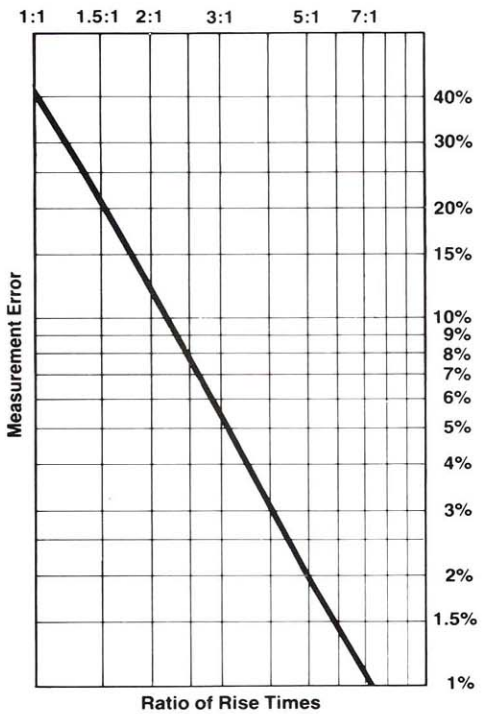
While a bandwidth specification is essential for the vertical system(s) of a scope, bandwidth is also sometimes specified for the horizontal system (which gives you a chance to evaluate performance in X-Y measurement applications) and for trigger systems (which permits you to determine the range of possible triggering signals).

Although bandwidth is the most important spec when making amplitude measurements, risetime is the specification to use if you are making timing measurements.

The frequency response of most scopes is designed so that there is a constant that allows you to relate the bandwidth and risetime of the instrument with this approximation:

$$T_r = \frac{0.35}{BW}$$

Given either specification (bandwidth or risetime), you can derive the other and determine if the instrument is suitable for your applications. The rule of thumb for timing measurements is to use an instrument with a risetime at least five times faster than the measurement you expect to make. A 5:1 ratio gives you a risetime measurement with ≤2% error. Other ratios and measurment errors are shown in the chart below.




Note that very accurate absolute-risetime measurements are not always a requirement. When you are comparing risetimes, for instance, an instrument risetime equal to those being measured is often adequate.

**Sensitivity**
An oscilloscope sensitivity specification describes the input signal level needed to produce a stated deflection of the electron beam within the CRT. Specifications typically are given in mV/cm or mV/div; with this spec you can determine if small signals will be displayed with enough amplitude for you to make measurements quickly and accurately.

Note that at a given state-of-the-art, sensitivity and bandwidth are trade-offs. The small amount of noise in even the best input circuit will mask very small signals. Raising the bandwidth also increases the noise picked up by the amplifiers, requiring a larger signal to create a clear display. As a consequence of this relationship, many high-sensitivity scopes provide bandwidth-limiting controls to allow you to make cleaner low-level measurements at moderate frequencies.

Although sensitivity specifications are most often associated with oscilloscope vertical channels, this specification can also be provided for horizontal systems and for trigger circuits.

**Multiple Inputs**
It is often quite useful to be able to view more than one input signal without disturbing the connections to your scope. Common applications include: comparisons of a device's input and output signals; checking signals against standards; making timing and/or phase measurements between events. These measurement requirements are usually satisified by dual-trace oscilloscopes that use electronic switching to alternately connect two input signals to a single deflection system. Dual-trace scopes offer the lowest cost and the best comparison capabilities (because there is a single horizontal amplifier and one set of deflection plates). On the other hand, since a fast transient event might occur on one channel while the beam is tracing the other, dual-beam scopes like the Tektronix 7844 (page 336) and 5113 (page 277) are recommended for viewing single-shot phenomena. The 5113 has two independent vertical systems and a common horizontal system and can display up to eight waveforms in its chop vertical operating mode. The dual-beam 7844 can be equipped with dual-time base plug-ins and then used to see a single event at different locations in the signal path, at two sweep rates if necessary.

**Vertical System Operating Modes**
Multiple inputs, the Add vertical operating mode, and the ability to invert one channel lets you cancel or reject any signal components equal in amplitude and phase that appears at both inputs. This ability provides a simple and accurate way to measure the difference between two signals, and of rejecting most unwanted signal components common to both inputs (such as power supply hum).

Other vertical operating modes are Alternate (in which a complete waveform from one vertical channel is drawn before switching to draw the other), Chopped (in which the scope draws small parts of the waveforms while switching back and forth between the channels at a fixed rate), and Trigger View.

The Trigger View mode is useful anytime you measure events dependent on an external triggering event. This capability is particularly useful in scopes such as the 468, where a zero-delay trigger view circuit is provided.

**Horizontal System Considerations**
The horizontal system of a modern oscilloscope provides a built-in sawtooth sweep generator. With this constant-speed horizontal deflection, measurements calibrated directly in units of time are possible. (As a consequence, the horizontal system of a scope is often called the time base.) This permits direct measurement of time between events, accurate time measurements on small portions of pulse trains, and even time measurements on single, nonrecurrent events.

**Sweep Speeds**
How fast a sweep speed do you need? One rule states that for frequency measurements at moderate frequencies, a sweep capable of displaying one cycle across the full horizontal scale is usually considered adequate. For example, one cycle of a 10 MHz signal can be displayed across 10 div with a 10 ns/div sweep. Don't apply this rule at ultrahigh frequencies, however, as scopes seldom have sweeps that fast.

Another approach emphasizes risetime measurements. For maximum accuracy here, the scope should show the step signal (squarewave, pulse, etc.) across most of the full vertical scale with the rising portion of the signal at nearly a 45° slope. For very fast risetimes, this objective is rarely met because of compounding difficulties and the cost of providing extremely fast sweeps which are both linear and accurate.

Though neither rule can be applied at the very limits, fast sweep speeds are readily available: sweeps to 5 ns (500 ps/div magnified) in the portable 2465; to 200 ps/div with plug-in time bases for laboratory scopes; or to 10 ps/div with sampling plug-ins. (See Sampling Applications on page 222.)

**Delayed Sweep Measurements**
Delayed sweep scopes can offer you many measurement advantages. If the scope has two calibrated time bases and the alternate horizontal operating mode (electronic switching of the trace between time bases), then convenient comparisons of the same signal at two different sweep speeds are possible.

If the second time base has an independent trigger, then jitter-free measurements on the delayed sweep are possible.

In every case, timing measurements with delayed sweep are easier to make, and in most cases, there is increased timing measurement accuracy. Many plug-in time bases for laboratory scopes and most portable scopes offer delayed sweep.

**Accuracy**
Accuracy in a scope's horizontal system is as important to timing measurements as vertical accuracy is to amplitude measurements. Horizontal accuracy to 1.5% is possible with several 7000 Series plug-in time bases and to 1% with the 2445 and 2465 Portable oscilloscopes.

**Probe Considerations**
An oscilloscope can only display a waveform as accurately as it receives it. Thus, a high accuracy Tektronix probe will complete a measurement system by establishing this critical link between the scope and circuit under test.

A wide range of Tek probes available to solve your specific measurement problems begin on page 436.

**Trigger System Considerations**
Besides sensitivity and bandwidth, the flexibility of a trigger system should be a consideration when choosing a scope. Some trigger system features you might need for your measurement applications include:

High and low frequency reject coupling — for stable triggering with noisy signals.
TV triggering — for automatic synchronization with video signals.
Alternate triggering — for steady display of either signal with dual-channel scopes.
Peak-to-peak auto triggering — for quick, convenient triggering with automatic level limits.
Variable trigger holdoff — permits trigger holdoff period to be varied to trigger on repetitive complex waveforms.
Single sweep operation — for special applications such as capturing a transient pulse and for CRT photography.

By combining logic analyzer triggering capabilities with an oscilloscope, digital signals can be displayed in analog form for measurements of time and amplitude. The 7A42 Logic Triggered Vertical Amplifier extends the 7000 Series triggering into the arena of logic analysis. The 2400 Series now offers NEW Counter/Timer/Trigger options and three Special Edition scopes to provide two new capabilities: delay-by-events triggering and Boolean logic triggering.

**CRT System Considerations**
CRT system specifications will tell you how well the scope can display waveforms for direct viewing and for photography. A full complement of CRT system controls contributes greatly to the instrument's ease of use.

**CRT Controls**
CRT system controls to consider include:
Beam Finder — A single pushbutton that allows you to quickly locate any off-screen trace.
Auto Focus — Auto focusing on both laboratory and portable scopes reduces the need for manual readjustments with changes in trace intensity; very useful when traces are displayed at different sweep rates as in alternate time base operations.
Auto Intensity — Maintains optimum trace intensity over a wide sweep-speed range.
External Z-Axis Input — Permits trace brightness modulation, makes some measurements easier by identifying events with an intensified zone on the trace.

## PHOTOGRAPHIC WRITING RATE

Photographic writing rate is a measure of the scope/camera/film's capability to record high speed signals.

Recording high speed signals on film is dependent on at least three factors, the oscilloscope used, film charcteristics, and the camera. For maximum writing rate capability, the objective is to get as much light energy to the film surface as possible. Since each component affects photographic writing rate, the selection for top performance is important.

The fastest writing rate oscilloscopes available are the 7104/R7103. At 20 cm/ns, the 7104/R7103 utilizes a unique microchannel plate CRT with GH (P31) phosphor standard. The chart shown graphs the response of the 7104/R7103 along with other 7000 Series mainframes and the 485 portable oscilloscope. (The other instruments shown in the graph utilize optional BE (P11) phosphor to achieve the writing rate performance indicated.)

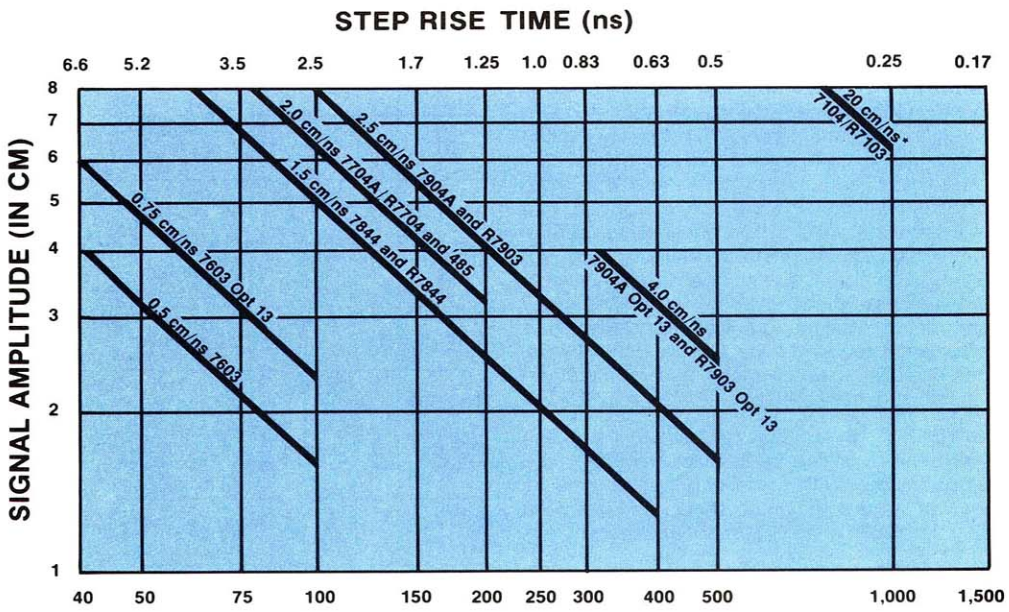
Tektronix manufactures a variety of cameras designed for use with oscilloscopes. Two key parameters are the f-number of the lens and the magnification. These parameters affect the light gathering capability of the camera. The chart utilizes a f/1.2 Tektronix C-51 Camera. More information on cameras is available on page 418.

Film characteristics are also an important parameter. Generally, the higher the ASA rating of the film used, the higher the film sensitivity and thus, photographic writing rate. It should be recognized that film speed can vary with storage conditions and environmental factors. More information is available from film vendors.

### Writing Rate Comparison Graph

On the graph, vertical signal amplitude on the vertical scale is shown against maximum sinewave frequence (lower scale) and fastest risetime (upper scale). These speeds assume a small horizontal spot velocity compared to the maximum vertical velocity. The ramp is assumed to be a linear ramp measured between the 10% and 90% points.

There is an application note available from Tektronix which further describes photographic writing rate, including measurement procedures and applications. It is available on request by referencing 42W-5335.




*Amplitude vs speed and photographic writing speed comparison of 7000 Series mainframes using BE (P11) phosphors (Option 78). 20,000 ASA film and the C-51 (f/1.2, 1:0.5) Camera.*

*BE (P11) phosphor has a different spectral output than GH (P31) phosphor standard and more closely matches the sensitivity spectrum of silver halide film types. While photographic writing speed is approximately two times the GH (P31) rate, the visual output luminance is approximately 15% of GH (P31) phosphor standard. Using Polaroid Film Type 107, 3,000 ASA w/out film fogging.*

** 20 cm/ns is the specified photographic writing speed for the 7104/R7103 Mainframe. However, it is not directly comparable to the other mainframes here because of relaxed phosphor, film and camera requirements. The microchannel plate CRT as well as the bright photographed image allow for these relaxed requirements. Standard GH (P31) phosphor standard is used and a C-53 (f/1.9, 1:0.85 image) Camera, using Polaroid Type 107, 3,000 ASA without film fogging.*

### Writing Speed Enhancer

A writing speed enhancer provides controlled fogging of the film to increase its sensitivity. The degree of writing speed improvement is variable, and is dependent on the film, camera, and scope combination used. More information is available on page 419.

### Selecting a Phosphor

The catalog description of each oscilloscope indicates the phosphors normally supplied or available as options. While a special phosphor may be desirable for a specific measurement application, remember that each phosphor has its own color, persistence, burn resistance, etc. Improvements in one characteristic are usually at the expense of others. The chart below provides comparisons.

### COMPARATIVE CRT PHOSPHOR DATA

| Phosphor*1 | | Fluorescence | Phosphorescence Where Different from Fluorescence | Relative Luminance*2 | Relative Photographic Writing Speed*3 | Decay | Relative Burn Resistance | Comments | Ordering Information Option |
|---|---|---|---|---|---|---|---|---|---|
| WTDS | JEDC | | | | | | | | |
| GJ | P1 | Yellowish-green | — | 50% | 20% | Medium | Medium | Replaced by GH (P31) in most applications | Special order |
| WW | P4 | White | — | 50% | 40% | Med-Short | Med-High | Television displays | 74 |
| GM | P7 | Blue | Yellowish-green | 35% | 75% | Long | Medium | Long decay, double-layer screen | 76 |
| BE | P11 | Blue | — | 15% | 100% | Med-Short | Medium | For photographic applications | 78 |
| GH | P31 | Green | — | 100% | 50% | Med-Short | High | General purposes, brightest available phosphor | 80 |
| GR | P39 | Yellowish-green | — | 27% | NA*4 | Long | Medium | Low refresh rate displays | 40 |
| GY | P43 | Yellowish-green | | 40% | NA*4 | Medium | Very High | High current density phosphor | Special order |
| GX | P44 | Yellowish-green | | 68% | NA*4 | Medium | High | Bistable storage | |
| WB | P45 | White | — | 32% | NA*4 | Medium | Very High | Monochrome TV displays | |

**1 Tektronix is adopting the Worldwide Phosphor Type Designation System (WTDS) as a replacement for the older JEDEC "P" number system referenced in this catalog. The chart lists the comparable new WTDS designations for the most common "P" numbers.*

**2 Measured with Tektronix J16 Photometer and J6523 Luminance Probe which incorporates a CIE standard eye filter. Representative of 10 kV aluminized screens. GH (P31) as reference.*

**3 BE (P11) as reference with Polaroid 612 or 106 film. Representative of 10 kV aluminized screens.*

**4 Not available.*

## DIGITAL ADDITIONS

You can make delay and time interval measurement with digital ease on several Tektronix oscilloscopes. The 2400 Series offers *NEW* Counter/Timer/Trigger options for the standard instrument and the three *NEW* Special Edition 2465's. These CTT options provide crystal-controlled time base accuracy for several time related measurements and are fully integrated with the operation of the scope and user on-screen menus. The DM 44 factory-installed option for 464/466 Storage Oscilloscopes allows you to read the delay time, time interval, or frequency right from an LED readout, with no calculation or interpolation required. The DM 44 also incorporates a digital volt/ohm meter and temperature-measurement capabilities.

The 7B10, 7B15, 7B85 and 7B80 plug-ins for the 7000 Series oscilloscopes also provide Δtime measurements. With these plug-ins the time interval measurement can be shown on the screen using the 7000 Series CRT readout capability.

For 7000 Series instruments, there is a wide variety of other digital plug-ins. These include a universal counter/timer, a digital multimeter with a temperature mode, digital delay by time or events, a versatile 0.01% A/D converter with vertical amplifier, and a special read-out unit to label each test for future reference.

Combining digital capabilities within the oscilloscope system offers many advantages over separate test units such as: increased accuracy, scope-controlled digital measurements, measuring convenience and confidence, easier and faster solutions to complex problems, a lower dollar investment, more bench space, and signal conditioning.

## SAMPLING APPLICATIONS

Sampling is a powerful technique for examining very fast repetitive signals. In principle, sampling is similar to the use of stroboscopic light to study fast mechanical motion. Progressive samples of different portions of successive waveforms are taken; then they are "stretched" in time, amplified by relatively low-bandwidth amplifiers, and finally shown (all seemingly at one time) on the screen of a CRT. The display produced is a replica of the sampled waveforms.

This sampling technique is limited to depicting repetitive signals, since no more than a portion of the signal is captured and displayed each time the signal occurs. The sampling method, however, provides a means of examining fast-changing signals of low amplitude that cannot be examined in any other way.

Sampling scopes are capable of resolving events that occur in less than 30 ps on an "equivalent" time base of less than 20 ps/div with less than 5 mV of peak amplitude.

If your measurement needs require equivalent bandwidths to 14 GHz or sweeps to 10 ps/div, consider the sampling plug-ins described on page 268.

To determine which instrument fits your requirements, refer to the sampling decision tree on page 265.

## MODULAR NONSTORAGE OSCILLOSCOPES

| Product | Bandwidth*1 | Minimum Deflection Factor | Number of Traces | Maximum Sweep Rate | Delayed Sweep | Page | Price*2 |
|---|---|---|---|---|---|---|---|
| 7104<br>R7103 | 1 GHz | 10 mV/div at BW | up to 4 | 200 ps/div | X | 234 | $22,705<br>$22,920 |
| 7904A<br>R7903 | 500 MHz | 10 mV/div at BW<br>10 μV/div<br>1 mA/div | up to 4 | 500 ps/div | X | 236 | $9,085<br>$8,780 |
| 7844<br>R7844 | 400 MHz | 20 mV/div at BW<br>10 μV/div<br>1 mA/div | up to 4<br>Dual-Beam | 1 ns/div | X | 242 | $14,265<br>$14,705 |
| 7704A<br>Opt 09 | 250 MHz | 20 mV/div at BW<br>10 μV/div<br>1 mA/div | up to 4 | 2 ns/div | X | 238 | $5,160 |
| 7704A<br>R7704 | 200 MHz | 10 mV/div at BW<br>10 μV/div<br>1 mA/div | up to 4 | 2 ns/div | X | 238 | $4,660<br>$7,895 |
| 7603<br>R7603 | 100 MHz | 5 mV/div at BW<br>10 μV/div<br>1 mA/div | up to 4 | 5 ns/div | X | 240 | $2,955<br>$3,385 |
| 5440<br>R5440 | 50 MHz | 5 mV/div at BW<br>10 μV/div<br>0.5 mA/div | up to 8 | 5 ns/div | X | 284 | $2,955<br>$3,020 |
| 5110<br>R5110<br>5116 | 2 MHz | 1 mV/div at BW<br>10 μV/div<br>0.5 mA/div | up to 8 | 100 ns/div | X | 276<br><br>278 | $1,610<br>$1,675<br>$2,360 |

**1 Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.*
**2 Price does not include plug-ins.*

## PORTABLE NONSTORAGE OSCILLOSCOPES

| Product | Bandwidth | Minimum Deflection Factor | Dual-Trace | Maximum Sweep Rate | Delayed Sweep | Page | Price |
|---|---|---|---|---|---|---|---|
| 485 | 350 MHz | 5 mV/div at BW | X | 1 ns/div | X | 290 | $8,675 |
| 2465<br>2465CTS*2<br>2465DMS*2<br>2465DVS*2 | 300 MHz | 2 mV/div at BW | 4 channel | 500 ps/div | X | 292 | $5,150<br>$6,650<br>$7,850<br>$8,550 |
| 2445 | 150 MHz | 2 mV/div at BW | 4 channel | 1 ns/div | X | 292 | $3,550 |
| 2337 | 100 MHz | 5 mV/div at BW | X | 5 ns/div | X | 299 | $3,600 |
| 2336<br>2336YA | 100 MHz | 5 mV/div at BW | X | 5 ns/div | X | 299 | $3,200<br>$3,275 |
| 2335 | 100 MHz | 5 mV/div at BW | X | 5 ns/div | X | 299 | $2,900 |
| 2235<br>2235 Opt 01 | 100 MHz | 5 mV/div at BW<br>2 mV/div | X | 5 ns/div | X | 303 | $1,650<br>$1,995 |
| 2236 | 100 MHz | 5 mV/div at BW<br>2 mV/div | X | 5 ns/div | X | 303 | $3,200 |
| 2215A | 60 MHz | 5 mV/div at BW<br>2 mV/div | X | 5 ns/div | X | 307 | $1,450 |
| 2213A | 60 MHz | 5 mV/div at BW<br>2 mV/div | X | 5 ns/div | X | 307 | $1,200 |
| 305 | 5 MHz | 5 mV/div at BW | X | 100 ns/div | | 309 | $2,405 |
| 221 | 5 MHz | 5 mV/div at BW | X | 100 ns/div | | 310 | $2,100 |
| 213 | 1 MHz | 20 mV/div at BW<br>5 mV/div | | 400 ns/div | | 311 | $2,625 |
| 212 | 500 kHz | 10 mV/div at BW<br>1 mV/div | X | 1 μs/div | | 312 | $1,895 |
| SC 504*1 | 80 MHz | 5 mV/div at BW | X | 5 ns/div | | 391 | $3,395 |
| SC 502*1 | 15 MHz | 5 mV/div at BW<br>1 mV/div | X | 20 ns/div | | 393 | $2,480 |

**1 The SC 502 and SC 504 are oscilloscopes that must be plugged into a TM 500/TM 5000 mainframe for operation.*
**2 Programmable via GPIB, useful in Automated Test Applications.*

## STORAGE

When a conventional oscilloscope cannot capture an event and display it for your measurements because the signal is too slow, or too fast and infrequent, or when you need to compare events that happen at different times instead of simultaneously, consider a storage scope. These are obvious applications, but there are many other situations that also call for the unique advantages of storage. Storage can help you:

Observe signal changes during circuit adjustments
Compare new signals with a standard
Increase the brightness of a dim, low-repetition-rate signal for normal viewing
Reduce flicker or noise in a signal
Babysit (unattended monitoring) for a transient event
Capture fast signals that occur infrequently or only once
Capture a complete display of a slowly occurring signal
Enhance other record-keeping techniques like photography

With the right Tektronix storage instrument, the capabilities you need are available, and the storage time can be anywhere from a few minutes to a practically unlimited length of time depending on your choice of instruments.

### Only Tektronix Offers Four Distinct Storage Technologies

Two broad categories of storage instruments are named for the storage medium. CRT storage scopes store the captured waveform when the electron beam writes on a target within the cathode-ray tube. Digital storage scopes quantize the waveform and then store it in a digital memory. In addition there are waveform digitizers; a very special class of storage instruments available in the Tektronix 7000 Series. Within each category there are different technologies and each has its own set of features and benefits.

### Bistable CRT Storage

The phosphor in a bistable CRT storage scope has two stable states: written and unwritten. Once stored, this phosphor allows waveforms to be displayed typically for several hours, or until it is erased by the operator. Bistable storage is the easiest CRT storage type to use. It is also the least expensive CRT storage technology. It features bright, long-lasting displays, but in comparison with other storage technologies, bistable storage displays have less contrast.

The advantages of bistable storage make it particularly useful for mechanical measurements, signal comparisons, and data recording.

Split-screen viewing is another advantage of most bistable storage scopes. The feature allows a reference waveform to be stored on one half the screen while the other half can be used to store the effects of changes made on the circuit. You can also use the split screen to have the reference waveform in the stored mode and the other half of the display in the nonstored mode to monitor an external input.

### Variable Persistence CRT Storage

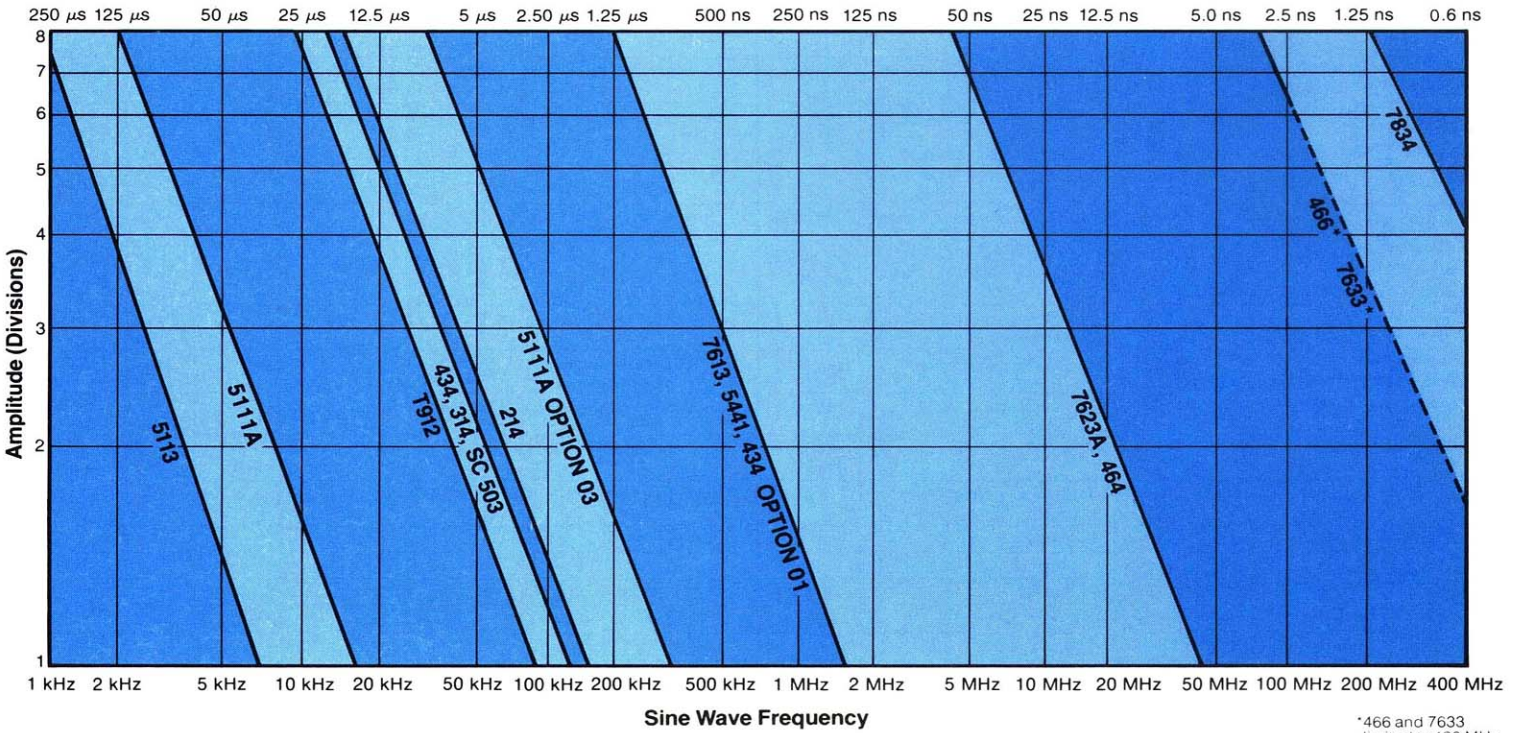
If you don't need to store waveforms for hours at a time, variable-persistence CRT storage has advantages. The variable-persistence storage CRT has a storage mesh where the electron beam writes the input signal; thereafter, flood guns in the CRT illuminate the phosphor where the storage mesh permits.

CRT storage controls vary the charge on the mesh, allowing you to control the contrast between the trace and the background and to fine tune how long the trace is stored.

The first capability provides easy viewing with high constrast between the dark background and bright waveforms. And this type of storage provides the best displays when viewing traces with varying intensities (such as delaying and delayed sweeps, or traces with external z-axis intensity modulation).

## CRT STORAGE PERFORMANCE

**Step Rise Time**




*466 and 7633 limited to 100 MHz vertical bandwidth

Varying the persistence permits you to set up the scope so that the entire waveform can be viewed, yet the stored trace will fade from view just as a new waveform is being stored. Or you can view several traces before the first one fades from view. Then you can see signal response variations as you make changes in a circuit.

Variable persistence can also be used to provide display integration so that only the coincident portions of a repetitive signal are displayed. Aberration or jitter not common to all traces will not be stored or displayed. Low repetition rate, fast risetime signals that are not discernible on conventional CRT's can be easily viewed with this storage technology by allowing each repetition to build up the trace brightness.

Applications for variable persistence storage include spectrum analysis, time-domain reflectrometry, sampling, and any other measurements that require displays of low-repetition-rate signals.

**Fast Transfer CRT Storage**

Fast transfer storage scopes use a CRT with a special intermediate mesh target optimized for speed. This target captures the waveform and then transfers it to another mesh, one optimized for longer-term storage. As the name implies, the fast transfer storage mode provides increased writing speed (see the next heading) for the 466 Portable Oscilloscope and the 7623A, 7633, and 7834 lab scopes.

The second target can also be designed to offer bistable, variable persistence or both modes in combination with the transfer mesh or by itself. In the 7623A, 7633, and 7834, this combination of capabilities provides unique multi-mode storage instruments. Using front panel controls, you can select the operating mode suited to your specific measurement situation.

**Stored Writing Speed**

For CRT storage scopes, the storage capability specification is the stored writing speed. This figure of merit is expressed in distance per unit of time. Often div/$\mu$s is more meaningful in terms of your measurements. But because some scopes have nonstandard sized graticules (i.e., other than 1 cm square major divisions) cm/$\mu$s is useful for comparisons.

The specification is dependent on the speed and amplitude of the input signal. If you know the pulse risetime or sinewave frequency of the input signal and the amplitude of the waveform you want to display, you can use the chart on page 223 to determine which storage scope is recommended.

**CRT STORAGE OSCILLOSCOPES**
**(In Order of Stored Writing Speed)**

| Product | Stored Writing Speed | View Time | Type of Storage | Bandwidth*1 | Minimum Deflection Factor | Number of Traces | Delayed Sweep | Plug-in | Page | Price |
|---|---|---|---|---|---|---|---|---|---|---|
| 7834 | 5500 div/$\mu$s<br>776 div/$\mu$s<br>12 div/$\mu$s<br>0.2 div/$\mu$s | 30 s*3<br>30 min*4 minimum<br>30 s*3<br>30 min*4 minimum | Fast variable persistence<br>Fast bistable<br>Variable persistence<br>Bistable | 400 MHz | 20 mV/div at BW;<br>10 mV/div at 325 MHz | Up to 4 | X | X | 244 | $13,055 |
| 466 | 3000 div/$\mu$s<br>3 div/$\mu$s | 15 s*3<br>15 s*3 | Fast variable persistence<br>Variable persistence | 100 MHz | 5mV/div at BW | Up to 2 | X | | 314 | $7,270 |
| 7633 | 2200 div/$\mu$s<br>400 div/$\mu$s<br>3 div/$\mu$s<br>0.2 div/$\mu$s | 30 s*3<br>30 min<br>30 s*3<br>30 min minimum | Fast variable persistence<br>Fast bistable minimum<br>Variable persistence<br>Bistable | 100 MHz | 5 mV/div at BW; 10 $\mu$V/div;<br>1 mA/div | Up to 4 | X | X | 246 | $8,660 |
| 7623A | 150 div/$\mu$s<br>50 div/$\mu$s<br>0.5 div/$\mu$s<br>0.03 div/$\mu$s | 30 s*3<br>30 min minimum<br>30 s*3<br>30 min minimum | Fast variable persistence<br>Fast bistable<br>Variable persistence<br>Bistable | 100 MHz | 5 mV/div at BW; 10 $\mu$V/div;<br>1 mA/div | Up to 4 | X | X | 246 | $6,700 |
| 464 | 110 div/$\mu$s<br>0.5 div/$\mu$s | 15 s*3<br>15 s*3 | Fast variable persistence<br>variable persistence | 100 MHz | 5 mV/div at BW | Up to 2 | X | | 314 | $6,150 |
| 7613 | 5 div/$\mu$s | 1 hr | Variable persistence | 100 MHz | 5 mV/div at BW; 10 $\mu$V/div;<br>1 mA/div | Up to 4 | X | X | 248 | $6,110 |
| 5441 | 5 div/$\mu$s | 1 hr | Variable persistence | 50 MHz | 5 mV/div at BW; 10 $\mu$V/div;<br>0.5 mA/div | Up to 8 | X | X | 285 | $5,010 |
| 434 Opt 01<br>434 | 5 div/$\mu$s<br>0.4 div/$\mu$s | 4 hr | Bistable split screen | 25 MHz | 10 mV/div at BW; 1 mV/div | Up to 2 | | | 316 | $6,070<br>$5,620 |
| 5111A Opt 03<br>5111A | 0.8 div/$\mu$s<br>0.05 div/$\mu$s | 10 hr | Bistable split screen | 2 MHz | 1 mV/div at BW; 10 $\mu$V/div;<br>0.5 mA/div | Up to 8 | X | X | 276 | $2,755<br>$2,605 |
| 214 | 0.5 div/$\mu$s | 1 hr | Bistable | 500 kHz | 10 mV/div at BW; 1 mV/div | Up to 2 | | | 318 | $2,600 |
| 314 | 0.4 div/$\mu$s | 4 hr | Bistable | 10 MHz | 2 mV/div at BW | Up to 2 | | | 317 | $4,050 |
| T912 | 0.25 div/$\mu$s | 4 hr | Bistable | 10 MHz | 2 mV/div at BW | Up to 2 | | | 319 | $2,255 |
| SC 503*2 | 0.08 div/$\mu$s | 4 hr | Bistable | 10 MHz | 1 mV/div at BW | Up to 2 | | | 392 | $3,650 |
| 5113 | 0.02 div/$\mu$s | 10 hr | Bistable split screen | 2 MHz | 1 mV/div at BW; 10 $\mu$V/div;<br>0.5 mA/div | Up to 8<br>dual-beam | X | X | 277 | $3,785 |

**1 Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.*

**2 The SC 503 is an oscilloscope that must be plugged into a TM 500/TM 5000 Mainframe for operation. Please turn to page 392 for more information.*

**3 View times are at full stored display intensity. They may be increased by using reduced intensity in the save display mode.*

**4 Save intensity at minimum.*

### Digital Storage

The fundamental difference between digital storage scopes and CRT storage scopes is that digital scopes quantize the captured waveform and CRT storage scopes do not. Having quantized waveforms in a digital memory gives you measurement capabilities not possible with any other kind of oscilloscope.

With digital storage scopes, you have the advantage of pretrigger viewing. In other words you can look at a waveform both before and after the trigger event. Another feature is "baby-sitting"; available because the digital storage scope's trigger can stop, as well as start signal acquisition.

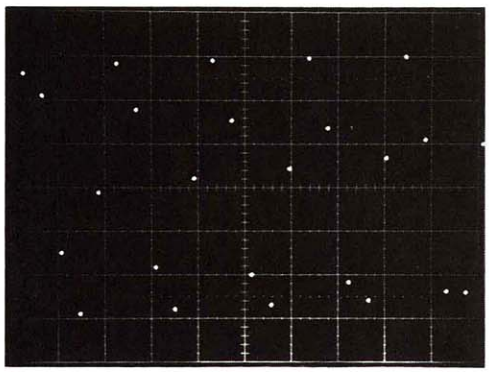
Other digital storage scope advantages include signal processing features like averaging a number of samples of the input signal to reduce the effects of noise; performing calculations on the waveform parameters; or outputting the signal data over RS-232 or GPIB standard interfaces.

Digital storage scopes are typically easy to use and give you crisp, clear displays. Because the data is stored in a digital memory, no fading or blooming of the trace on the CRT phosphor will occur, and storage time is essentially unlimited. This type of storage is excellent for many applications involving single-shot or low-repetition signals, or where the unique advantages of a digitized waveform may be the answer to your measurement needs.

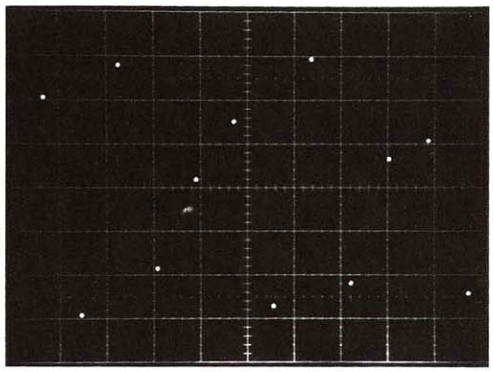
### Quantization Techniques

Within digital storage scopes there are two main techniques of quantizing signals—and the technique has a direct effect on the applications of the instruments in that only one kind of digital storage scope can capture single-shot signals.

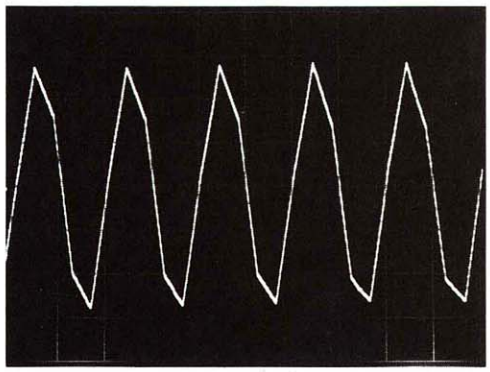
The digital scopes that can capture signals in a single sweep use what is called "real-time sampling". Other digital storage scopes use "equivalent-time sampling". There are two equivalent-time sampling methods and both require many repetitions of the input signal. In exchange for that requirement, you have the ability to measure signals more than ten times faster than can be captured with real-time sampling.



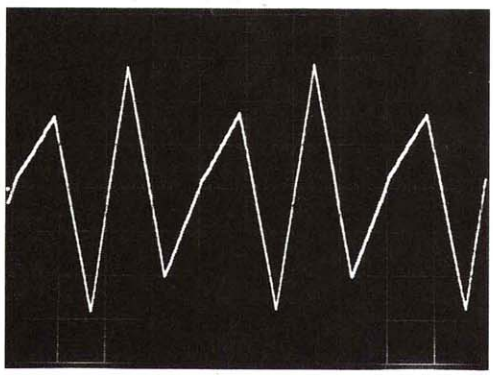
*With Dot Display 5 MHz Signal*



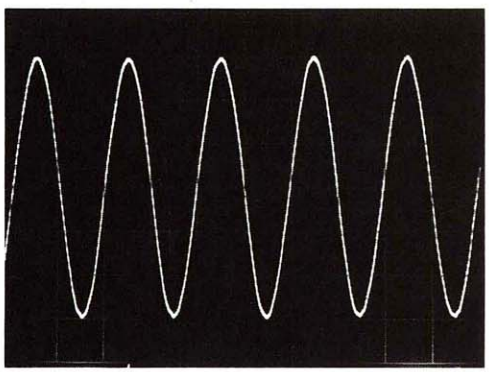
*10 MHz Signal*



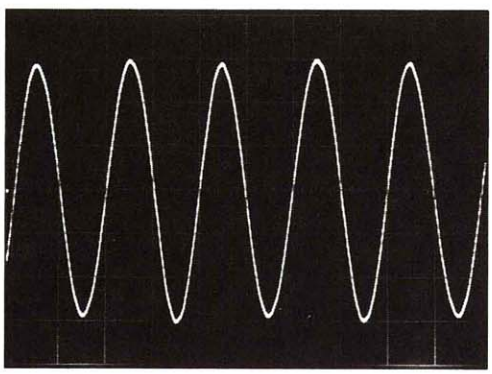
*With Pulse Interpolator 5 MHz Signal*



*10 MHz Signal*



*With Sine Interpolator 5 MHz Signal*



*10 MHz Signal*

*Digitizing Rate — 25 MHz*

### Digital Storage Scope Specifications

For digital storage oscilloscopes that use real time sampling, there is a useful storage bandwidth specification. It expresses the highest frequency sinewave that can be captured in a single sweep and displayed so that you can make measurements. Both the digitizing rate (how often the scope takes samples) and the display reconstruction technique (how the scope displays what's in its memory) must be taken into account in the useful storage bandwidth. See the examples below.

For digital scopes using equivalent time sampling, the specificaton is "equivalent-time bandwidth", the highest frequency signal that can be stored and displayed with less than 3 dB signal amplitude loss. Besides analog specifications (common to all oscilloscopes), other specifications of interest to digital scope users are:

Maximum Digitizing Rate—How often the instrument takes samples of the input signal.

Vertical Resolution (usually expressed in "bits of resolution)—How finely the instrument can discriminate between signals very much alike in voltage; for example, 8 bits of resolution is 0.391% when expressed as a percentage, and 10 bits is 0.098%.

Record length or Horizontal Resolution—How many words of digital memory are used to store the captured waveform; if the signal is stored in 512 data words, the horizontal resolution is 1 in 512 or 0.195%.

The Tektronix digital storage scopes are:

| | |
|---|---|
| 336 | Portable Digital Storage Oscilloscope. Useful storage bandwidth of 140 kHz, microprocessor controlled with features and modes chosen from menu on CRT. |
| 468 | Portable Storage Oscilloscope. Real-time sampling to 10 MHz and special features like the envelope operating mode, a very useful glitch-catching feature. |
| 5D10 | Waveform Digitizing Plug-in for the 5000 Series offering real time sampling to 100 kHz, CRT readout, 8-bit vertical resolution, and up to 1024 data words/waveform. |
| 5223 | Digitizing Oscilloscope with 10 bits of vertical resolution, roll mode, X-Y plotter output, and optional GPIB interface. |
| 7D20 | Waveform-Digitizing Plug-in for the 7000 Series offering dual samplers (capable of capturing two independent 25-ns-wide transient events) and with displays of six independent signals as well as a reference waveform. |
| 7854 | Waveform Processing Oscilloscope with 400 MHz equivalent-time bandwidth, keystroke programming, and calibrated sweep speeds to 500 ps/div. |

### Color Digital Storage Oscilloscope

Tektronix method of producing color oscilloscope displays, liquid crystal display technology, is described in the display technology reference section beginning on page 17. This technology is combined with digital storage in our 5116 Oscilloscope. Full product specifications are on pages 278-279. Tek's ***NEW*** C-4 and C-7 Cameras can save those color displays on color film. See page 422-424 for a complete description.

Your local Tektronix Sales Engineer, Representative, or Distributor can help you determine the digital oscilloscope parameters necessary to meet your measurement applications needs.

## TEKTRONIX DIGITIZER COMPARISON*[1]

| | 390AD Programmable Digitizer | 468 Digital Storage Oscilloscope | 5223 Digital Storage Oscilloscope | 7854 Waveform Processing Oscilloscope | 7912AD Programmable Digitizer | 7612D Waveform Digitizer | 7D20/7D20T Programmable Digitizer | 336 Digital Oscilloscope |
|---|---|---|---|---|---|---|---|---|
| **Page** | **338** | **330** | **344** | **336** | **342** | **340** | **333** | **332** |
| Digitizing Technique | Dual stage flash conversion | Flash conversion | Successive approx | Successive approx | Scan conversion | EBS*[2] flash conversion | CCD successive approx | Successive approx |
| Maximum Sample Rate | 60 MS/s (16.6 ns/point) | 25 MS/s (40 ns/point) | 1 MS/s (1 μs/point) | 500 KS/s (2 μs/point) | 100 GS/s (10 ps/point) | 200 MS/s (5 ns/point) | 40 MS/s (25 ns/point) | 1 MS/s (1μs/point) |
| Vertical Amplifier Analog Bandwidth | 15 MHz | 100 MHz | 10 MHz | 400 MHz/real (14 GHz/samp.) | 500 MHz /7A29 (200 MHz/7A16P) | 80 MHz | 70 MHz | 50 MHz |
| Vertical Resolution | 10 bits | 8 bits | 8 bits | 10 bits | 9 bits | 8 bits | 8 bits | 8 bits |
| Record Length (Points) | 2048 dual 4096 single | 256 to 512 | 254 to 1016 | 128 to 1024 | 512 | 256 to 2048 per channel | 1024 per channel | 1024 per channel |
| Input Channels | 2 | 2 chopped | Up to 4 chopped | Up to 4 chopped | 1 | 2 | 2 | 2 chopped |
| Independent Time Bases | 1 plus delaying | 1 plus delaying | 1 | 1 plus delaying | 1 | 2 | 1 | 1 plus delaying |
| Maximum Sweep Speed | N/A | 20 ns/div (2ns in X10) | 200 ns/div (20 ns in X10) | 500 ps/div (20 ps/div | 500 ps/div | N/A | 50 ns/div | 100 ns/div (10 ns in X10) |
| Pretrigger | Yes | Yes | Yes - with 5B25N | Yes - with 7B87 | delay line only | Yes | Yes*[3] | pre, mid, post |
| Posttrigger | Yes | Yes - with delaying | Yes - with delaying | Yes - with delaying | No | Yes | Yes | Yes |
| Waveform Storage Registers | 2 | 2 to 4 | 2 to 4 | 2 to 16 (5 to 40 Opt) | 1 | 2 to 16 | 6 | 2 plus 16 opt |
| Waveform Processing | | averaging enveloping | | averaging parameters keystroke programming | averaging | | averaging enveloping | averaging enveloping CH 1 ± CH 2 CH 1 X CH 2, RMS, mean, p-p |
| Waveform Data Output Format | binary | binary | ASCII or binary | ASCII | binary | binary | ASCII or binary | binary |
| Other | sample rate switching digital plotter output XY shift mode cursors | sine/pulse interpolator opt XY recorder out cursors | roll mode XY recorder output | measurement systems available waveform parameter calculations cursors | measurement systems available | sample rate switching measurement systems | roll mode cursors nonvolatile settings | XY output cursors CRT readout |
| Format Optimization | systems | operator | operator | operator | systems | systems | systems or operator | operator |

*[1] For applications not requiring programmability see the 5D10 Waveform Digitizer on page 279.*
*[2] Electron Bombarded Silicon.*
*[3] The 7D20/7D20T has pretrigger capability in the equivalent time digitizing range for repetitive waveforms as well as for single shot.*

### WAVEFORM DIGITIZERS

Along with conventional oscilloscopes, plug-in or integrated, and with storage oscilloscopes, both digital and analog, Tektronix leads the way in waveform acquisition instruments. This commitment to the future of test and measurement instrumentation can be seen today in three programmable waveform digitizers.

The 390AD Programmable Waveform Digitizer is a dual-channel waveform-acquisition digitizer with a maximum sampling rate of 30 MHz (or 60 MHz in single channel operations). Vertical resolution is 10 bits and the memory length is 2048 data words (4096, single channel) with one breakpoint provided to allow changing the digitizing rate during waveform digitizing. More information is available on page 338.

The 7612D Programmable Waveform Digitizer has full dual-channel operations, a maximum sampling rate of 200 MHz, selectable record lengths from 256 to 2048 data words, and the ability to change sampling rates several times during waveform digitizing. See page 340.

The 7912AD Programmable Transient Waveform Digitizer captures waveforms with a scan converter CRT capable of recording 500 MHz single-shot signals. See page 342 for more information if your applications demand equivalent digitizing rates to 100 GHz and 9-bit resolution both vertically and horizontally.

In addition to individual instruments, Tek now offers a new line of acquisition/processing packages and systems. These preconfigured packages and systems utilize our existing programmable waveform digitzers. See pages 346-352.

### TM 500 MANUAL INSTRUMENTS

The Tektronix TM 500 line is a modular system. One-, three-, four-, five-, and six-compartment mainframes accept a broad selection of plug-in instruments. The mainframe provides a common primary power supply, keeping total instrument weight, size, and cost down. Just as important, TM 500 mainframes also provide a signal control and data interface between modules. This allows TM 500 instruments to work either individually or together as integrated measuring systems. The Tektronix TM 500 Instrument line is extensive—more than 35 instruments, including digital multimeters, counter/timers, power supplies, signal sources, oscilloscopes, and more. Custom plug-in kits allow you to add your own unique circuits. With this feature, you can also apply TM 500's capability to unusual applications.

The TM 500 Instrument line has several configurations designed for portability. The TM 515 Traveler Mainframe, attractive and convenient enough to treat as carry-on luggage (it will even go beneath your seat on most airlines), is designed to take rugged travel. It carries up to five TM 500 plug-in instruments. The TM 503 three-compartment mainframe or the TM 504 four-compartment mainframe, with carrying case or protective cover, provide additional portability for the TM 500 instruments. Again, relatively lightweight, rugged construction, and convenient size are the key to portability.

### TM 5000 PROGRAMMABLE INSTRUMENTS

The Tektronix TM 5000 products extend the TM 500 concept of configurability to a line of IEEE Standard 488 compatible, fully programmable measurement, stimulus, and interfacing instruments. Tek's TM 5000 programmables are the easiest IEEE Standard 488 test and measurement instruments you can use. Because they are compatible with our TM 500 line of modular instrument, it is possible to configure literally hundreds of customized systems—systems that are programmable, manual, or hybrid—with plug-in, pull-out ease.

Tek's ***Standard Codes and Formats*** make communication between TM 5000 instruments easier than ever before. This same set of ***Standard Codes and Formats*** is used to communicate with other Tektronix IEEE Standard 488 instruments, such as the 2400 Family Oscilloscopes and 490P Series Spectrum Analyzers. TM 5000 commands are mnemonic. Each bus command is in "standard engineering English", matching the front panel nomenclature—ideal for the programmer who realizes the frustrations of working with many of today's instruments.

With the Learn Mode, one keystroke transfers a complete front panel setup to the controller for storage in memory. This greatly increases the productivity of the engineer by reducing setup time where test settings are constantly changing. You can change a routine without having to reprogram the whole system.

All TM 5000 programmables have an internal diagnostics capability designed right in. They perform self-test on power-up, and indicate an error if a malfunction has occurred. Plus they've all been designed for fast troubleshooting using signature analysis. All are UL listed.

As with TM 500, TM 5000 programmable systems take up less than half the space of standard rackmount equipment. This size advantage really pays off—on the bench, on the manufacturing floor, or in the field where portability is essential.

# 7000 SERIES INSTRUMENTS

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## The 7000 Series . . .

### Superior Performance

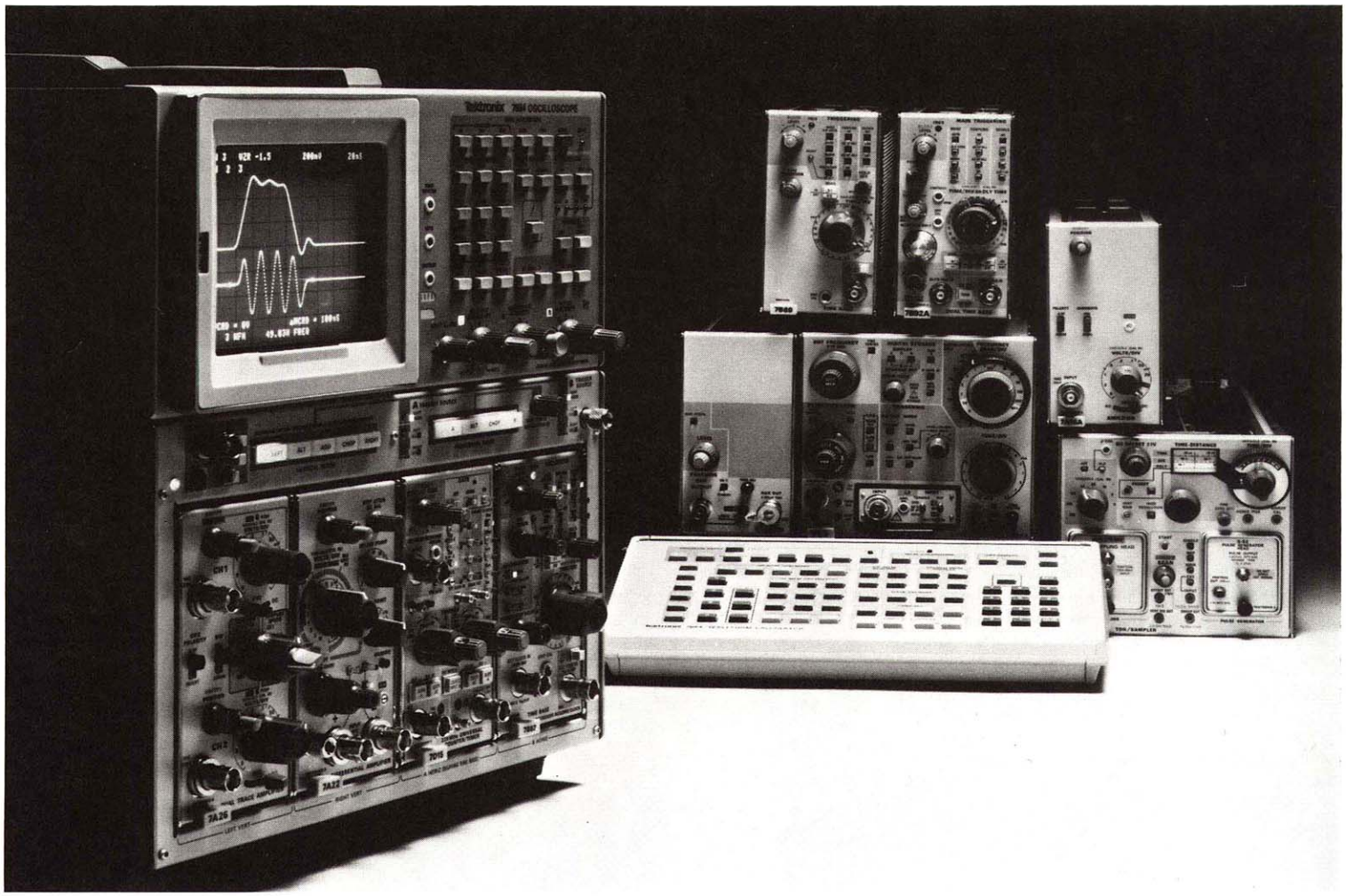
The 7000 Series of plug-in laboratory instruments embodies more state-of-the-art performance features than any other oscilloscope-based measurement system. The 7104 and the new R7103 Oscilloscopes feature a 1 GHz bandwidth combined with the fastest risetime and highest photographic writing speed available today.

### Flexibility

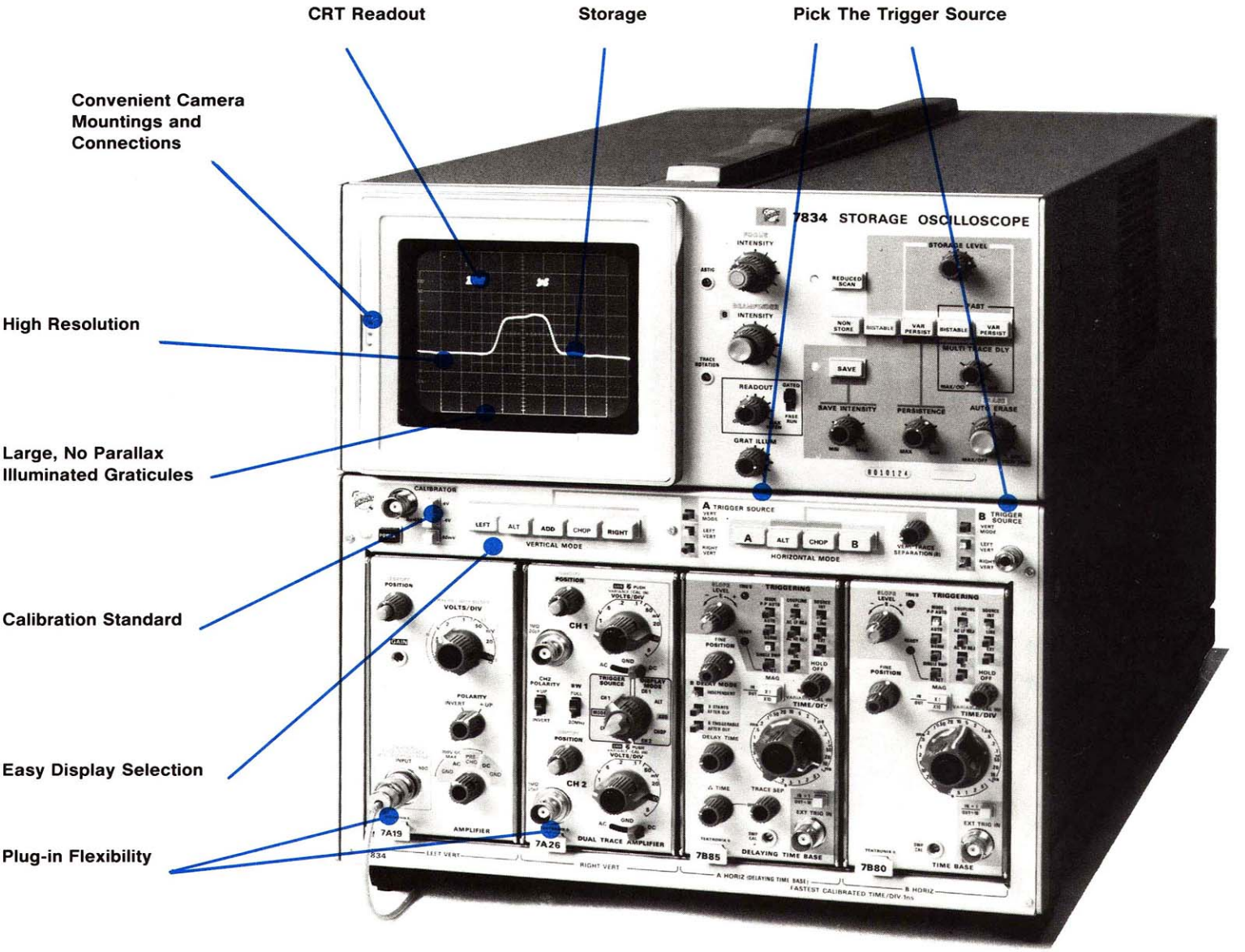
A choice of over 40 plug-ins and 19 mainframes gives you the flexibility to configure the scope package to meet your individual needs. When your needs change, your present package can be reconfigured with a minimum of additional equipment and effort.

### Expandability

This assures you that the instrument you buy today will adapt to changing measurement needs, and that it won't become obsolete soon after you buy it. Tektronix' most recent developments in plug-in scope capability are: the Waveform Processing Oscilloscope, the 1 GHz High Writing Rate Oscilloscope, the Programmable Digitizer Plug-In Unit, and the four channel Logic Triggered Vertical Amplifier.



## SUPERIOR PERFORMANCE, FLEXBILITY AND EXPANDABILITY




The 7000 Series is a unique family of instrumentation components, a continuation of the Tektronix commitment to bringing the ultimate in measurement technology to the laboratory.

Numerous measurement concepts—oscilloscopy, synergistic analog-digital measurements, spectrum analysis, sampling, time domain reflectometry, curve tracing—are fused into a family of interdependent CRT (cathode-ray-tube) mainframes and instrumentation plug-ins.

A system can be tailored for your exact measurement needs. Mainframes in the family offer a choice of popular bandwidth ranges and a wide selection of additional features. Plug-ins—including oscilloscope vertical amplifiers and time bases as well as instruments for a variety of applications—can be selected to round out your tailored system.

In contrast to an industrial world that is frequently faulted for planned obsolescence, the 7000 Series instrument family strategically defers obsolescence. Each mainframe and each plug-in reflects the latest technology at its inception, yet each fits a well-planned niche in this interdependent family. The result is an array of instrumentation components that can adapt to our new developments while protecting your initial investment. Today's system may be expanded to meet future needs at a relatively low cost by the addition of a plug-in or two. When the time comes to add a more powerful mainframe, your older model continues to be useful for a host of applications.

### CRT Readout*[1]

All significant parameters are displayed in alphanumeric characters right on the CRT. They are readily visible when you need them for quick oscilloscope measurements, and are permanently recorded on your waveform photographs for future analysis and documentation. When your 7000 Series measurement system includes a digital instrument plug-in, the measurement is presented in clear, accurate digital terms, along with a corresponding analog waveform.

### 400-MHz Dual-Beam

A dual-beam oscilloscope is essentially two oscilloscopes in one. A dual-beam oscilloscope is required in applications where two transient events must be compared simultaneously. These application areas commonly include the observation of simultaneous stimulation and reaction in such fields as medicine, biology, chemistry, and mechanical engineering.

### Digital Measurement Plug-ins

The 7000 Series digital plug-ins include: A universal counter/timer, digital multimeter with temperature measurement capability, digital delay by time or events, a versatile 0.01% A/D converter with vertical amplifier, and a special read-out unit to label each test for future reference. Together with a 7000 Series mainframe, these give you the advantage of seeing what you're measuring, plus accuracy of digital measurements.

### Sampling

The 7000 Series sampling plug-ins provide some unique measurement capabilities not available in other sampling oscilloscopes. You get: a low-cost storage CRT for slow scans, a random mode that lets you see leading edges without pretrigger or bandwidth-limiting delay line, a wide choice of sampling heads at minimal cost, and the convenience of sampling and conventional display at the same time on the CRT.

### CRT Storage

Eight 7000 Series mainframes provide some combination of CRT storage and/or variable persistence. The 7834 Storage Oscilloscope can capture single-shot transient events of <2 ns risetime. Variable persistence is valuable for effective viewing of slowly changing events or signals.

### Digital Storage

The 7854 Waveform Processing Oscillscope stores repetitive signals up to 400 MHz with conventional plug-ins, up to 14 GHz with the 7L12 TDR/Sampling plug-in. The 7854 provides digital storage with waveform processing, waveform measurements at the touch of a button, keystroke programming, and a GPIB interface. The 7D20 Programmable Digitizer plug-in provides dual-trace digital storage of signals up to 70 MHz in any 7000 Series mainframe, except the 7104.

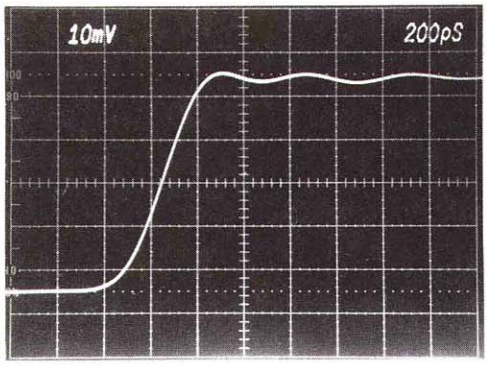
### Spectrum Analysis

Unexcelled plug-in performance from 20 Hz to 2.5 GHz is provided by the 7L5, 7L12 and 7L14 Spectrum Analyzer plug-ins. Stable, sensitive and spurious-free, these analyzers work in any 7000 Series mainframe.

Refer to the Spectrum Analyzer section beginning on page 201 for more information.

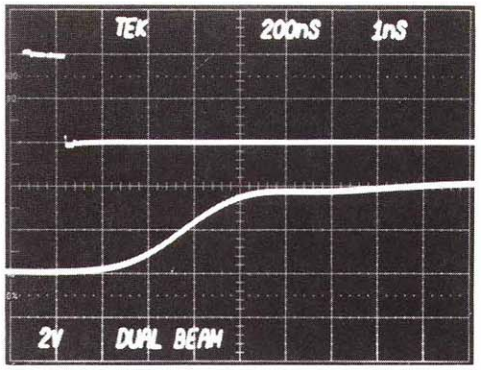
*[1] Not applicable for plug-ins with "N" suffix.*

## Nonstorage 1 GHz 7104/*NEW* R7103



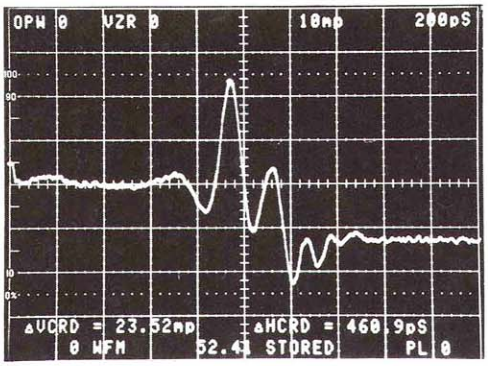

*This 300 ps risetime is displayed on a 7104 Oscilloscope. Readout indicates 10 mV/div vertical sensitivity and 200 ps/div sweep speed. The 7104 and R7103 provide ultra-bright displays which permit the viewing of a single-shot transient event up to the maximum bandwidth of the oscilloscope (1 GHz) in ambient light.*

## Dual Beam 7844/R7844



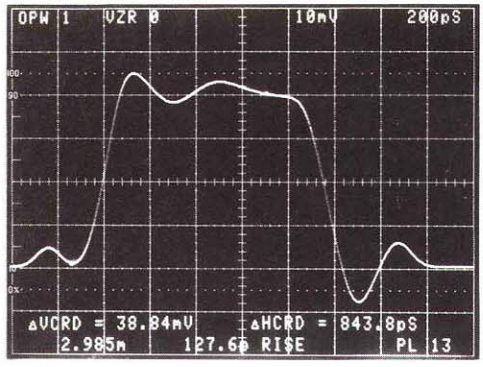

*The 400-MHz 7844 Dual-Beam Oscilloscope displays one input signal at two sweep speeds. The 7844 provides full vertical and horizontal crossover switching and full overlap of both vertical amplifiers on its 8 x 10 cm display.*

## Sampling/Time Domain Reflectometry



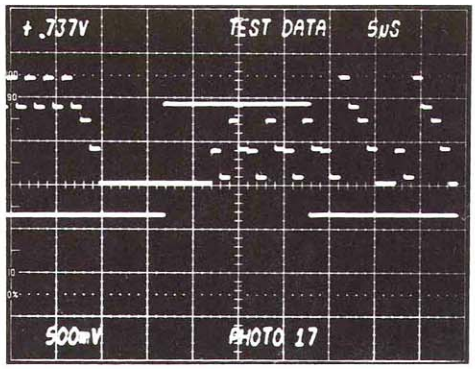

*7854 Waveform Processing Oscilloscope with 7S12 TDR/Sampling plug-in provides time domain reflectometry and digital processing of sampling. In this photo, the 7854/7S12 measures a discontinuity in millirho/division and calculates an impedance of 52.41 Ω at the discontinuity.*

## Digital Storage 7854



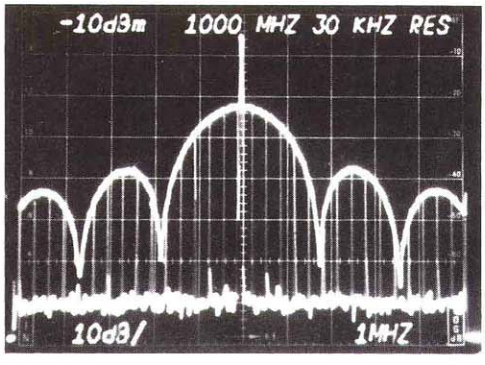

*Here, the 7854 measures the 127.6 ps risetime of a 38.83 mV pulse displayed at a sweep speed of 200 ps/div.*

## Digital Readout Measurements




*The 7D12/M2 A/D Converter and Sample/Hold Module measures +0.737 V difference between two points on a complex waveform. The leading and trailing edges of the gate waveform select the points on the signal to be measured.*

## Spectrum Analysis




*Max Hold feature of the 7L5 Spectrum Analyzer plug-in in a 7000 Series mainframe produces perfectly proportioned Sin x/x spectrum of low rep rate burst of 2.66 MHz, 6.67 µs in width.*

**CRT Storage see page 243.**
**Digitizers see page 329.**

## 7000 SERIES OSCILLOSCOPE SYSTEMS/PROBE SELECTION CHART*1

This selection guide lists the most popular combinations for optimum performance, but is not all inclusive. Current probes and other compatible probes are listed in the Probes Section on pages 436.

| | | PASSIVE VOLTAGE 1 MΩ INPUT COMPATIBLE | | | | | | | | PASSIVE VOLTAGE 50 Ω INPUT COMPAT | | ACTIVE PROBES 50 Ω/1 MΩ INPUT COMPATIBLE | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PROBE** | | **P6101** 1 m | **P6122** 1.5 m **P6105** 2 m | **P6130** 1.5 m **P6106** 1 m | **P6131** 1.3 m | **P6055*2** 3.5 ft | **P6062B*5** 6 ft | **P6009** 9 ft | **P6015** 10 ft | **P6056** 1.5 m | **P6057** 6 ft | **P6201*4** 6 ft | **P6202A*4** 2 m | **P6230*4** 1.5 m | **P6046** 6 ft |
| **FEATURES** | | Minature | Minature | Fast Risetime | Subminiature Fast Risetime | Adj Attenuation Differential | Selectable Attenuation 1X:10X | 1.5 kV | 40 kV Peak | Fastest 10X Passive Probe Low C | Fastest 100X Passive Probe Low C | Low Capactive Loading Ac Coupling Dc Offset | 10 MΩ Input Impedance Dc Offset | ECL Bias/ Offset | Differential High CMRR |
| **ATTENUATION** | | 1X | 10X | 10X | 10X | 10X | Selectable | 100X | 1000X | 10X | 100X | Selectable | Selectable | 10X | Selectable |
| **7100 FAMILY** | **7A19** | Nc | Nc | Nc | Nc | Nc | Nc | Nc | Nc | 500 MHz | 480 MHz | 430 MHz | 300 MHz | 480 MHz | 100 MHz |
| | **7A24** | Nc | Nc | Nc | Nc | Nc | Nc | Nc | Nc | 350 MHz | 350 MHz | 310 MHz | 300 MHz | 350 MHz | 100 MHz |
| | **7A26** | 34 MHz | 100 MHz | 175 MHz | | | | 125 MHz | 75 MHz | | | 195 MHz | 185 MHz | 200 MHz | 90 MHz |
| | **7A29** | Nc | Nc | Nc | Nc | Nc | Nc | Nc | Nc | 950 MHz | 800 MHz | 660 MHz | 450 MHz | 800 MHz | 100 MHz |
| | **7A42** | 34 MHz | 100 MHz | 250 MHz | 300 MHz | | | 130 MHz | 80 MHz | 350 MHz | 350 MHz | 300 MHz | 280 MHz | 350 MHz | 100 MHz |
| **7900 FAMILY** | **7A13** | 34 MHz | 75 MHz | 105 MHz | | 65 MHz | | 85 MHz | 65 MHz | | 105 MHz | 105 MHz | 105 MHz | 105 MHz | 70 MHz |
| | **7A15A** | 34 MHz | 75 MHz | 75 MHz | | | 75 MHz | 70 MHz | 60 MHz | | 80 MHz | 80 MHz | 75 MHz | 80 MHz | 60 MHz |
| | **7A16A** | 34 MHz | | 200 MHz | | | | 130 MHz | 80 MHz | | 205 MHz | 215 MHz | 205 MHz | 205 MHz | 90 MHz |
| | **7A18A** | 34 MHz | 75 MHz | 75 MHz | | | 75 MHz | 70 MHz | 60 MHz | | 75 MHz | 75 MHz | 75 MHz | 75 MHz | 60 MHz |
| | **7A19** | Nc | Nc | Nc | Nc | Nc | Nc | Nc | Nc | 500 MHz | 480 MHz | 430 MHz | 300 MHz | 480 MHz | 95 MHz |
| | **7A22** | 1 MHz | | Nc | Nc | 1 MHz | 1 MHz | | | | | | | | |
| | **7A24** | Nc | Nc | Nc | Nc | Nc | Nc | Nc | Nc | 350 MHz | 350 MHz | 310 MHz | 290 MHz | 350 MHz | 90 MHz |
| | **7A26** | 34 MHz | 100 MHz | 175 MHz | | | | 125 MHz | 75 MHz | | | 185 MHz | 185 MHz | 290 MHz | 85 MHz |
| | **7A42** | 34 MHz | 100 MHz | 250 MHz | 300 MHz | | | 130 MHz | 80 MHz | 300 MHz | 300 MHz | 300 MHz | 300 MHz | 300 MHz | 90 MHz |
| **7800 FAMILY** | **7A13** | 34 MHz | 100 MHz | 100 MHz | | 65 MHz | | 85 MHz | 60 MHz | | | 100 MHz | 100 MHz | 100 MHz | 70 MHz |
| | **7A15A** | 34 MHz | 75 MHz | 75 MHz | | | 75 MHz | 70 MHz | 55 MHz | | | 80 MHz | 80 MHz | 80 MHz | 60 MHz |
| | **7A16A** | 34 MHz | 100 MHz | 160 MHz | | | | 110 MHz | 75 MHz | | | 165 MHz | 170 MHz | 190 MHz | 85 MHz |
| | **7A18A** | 34 MHz | 85 MHz | 85 MHz | | | 85 MHz | 80 MHz | 60 MHz | | | 90 MHz | 75 MHz | 90 MHz | 65 MHz |
| | **7A19** | Nc | Nc | Nc | Nc | Nc | Nc | Nc | Nc | 400 MHz | 400 MHz | 360 MHz | 320 MHz | 400 MHz | 95 MHz |
| | **7A22** | 1 MHz | 1 MHz | Nc | Nc | 1 MHz | 1 MHz | 1 MHz | 1 MHz | | | | | | |
| | **7A24** | Nc | Nc | Nc | Nc | Nc | Nc | Nc | Nc | 300 MHz | 300 MHz | 280 MHz | 270 MHz | 300 MHz | 90 MHz |
| | **7A26** | 34 MHz | 100 MHz | 145 MHz | | | | 105 MHz | 75 MHz | | | 155 MHz | 150 MHz | 180 MHz | 85 MHz |
| | **7A42** | 34 MHz | 100 MHz | 200 MHz | 275 MHz | | | 110 MHz | 75 MHz | 275 MHz | 275 MHz | 260 MHz | 260 MHz | 275 MHz | 90 MHz |
| **7704A FAMILY** | **7A13** | 34 MHz | 70 MHz | 95 MHz | | 65 MHz | | 85 MHz | 65 MHz | | | 100 MHz | 100 MHz | 100 MHz | 70 MHz |
| | **7A15A** | 34 MHz | 70 MHz | 70 MHz | | | 70 MHz | 65 MHz | 55 MHz | | | 75 MHz | 70 MHz | 75 MHz | 55 MHz |
| | **7A16A** | 34 MHz | 100 MHz | 145 MHz | | | | 115 MHz | 75 MHz | | | 160 MHz | 150 MHz | 160 MHz | 80 MHz |
| | **7A18A** | 34 MHz | 75 MHz | 75 MHz | | | 75 MHz | 70 MHz | 60 MHz | | | 75 MHz | 75 MHz | 75 MHz | 60 MHz |
| | **7A19*3** | Nc | Nc | Nc | Nc | Nc | Nc | Nc | Nc | 250 MHz | 250 MHz | 220 MHz | 215 MHz | 250 MHz | 85 MHz |
| | **7A22** | 1 MHz | 1 MHz | Nc | Nc | 1 MHz | 1 MHz | | | | | | | | |
| | **7A24** | Nc | Nc | Nc | Nc | | Nc | Nc | Nc | 200 MHz | 200 MHz | 185 MHz | 180 MHz | 200 MHz | 80 MHz |
| | **7A26** | 34 MHz | 100 MHz | 140 MHz | | | | 105 MHz | 75 MHz | | | 160 MHz | 140 MHz | 165 MHz | 80 MHz |
| | **7A42** | 34 MHz | 100 MHz | 150 MHz | 180 MHz | | | 115 MHz | 75 MHz | 180 MHz | 180 MHz | 170 MHz | 160 MHz | 180 MHz | 80 MHz |
| **7600 FAMILY** | **7A13** | 34 MHz | 70 MHz | 75 MHz | | 55 MHz | 70 MHz | 60 MHz | 55 MHz | | | 75 MHz | 75 MHz | 75 MHz | 55 MHz |
| | **7A15A** | 34 MHz | 60 MHz | 60 MHz | | | 60 MHz | 55 MHz | 50 MHz | | | 65 MHz | 65 MHz | 65 MHz | 50 MHz |
| | **7A16A** | 34 MHz | 95 MHz | 95 MHz | | | 95 MHz | 85 MHz | 65 MHz | | | 100 MHz | 100 MHz | 100 MHz | 70 MHz |
| | **7A18A** | 34 MHz | 70 MHz | 70 MHz | | | 70 MHz | 65 MHz | 55 MHz | | | 75 MHz | 75 MHz | 75 MHz | 55 MHz |
| | **7A22** | 1 MHz | 1 MHz | Nc | Nc | 1 MHz | 1 MHz | | | | | | | | |
| | **7A26** | 34 MHz | 95 MHz | 95 MHz | | | 95 MHz | 85 MHz | 65 MHz | | | 100 MHz | 100 MHz | 100 MHz | 70 MHz |
| | **7A42** | 34 MHz | 95 MHz | 95 MHz | 100 MHz | | 95 MHz | 85 MHz | 65 MHz | | | 100 MHz | 100 MHz | 100 MHz | 70 MHz |

*1 *The values in the above table represent the approximate useful frequency response for the measurement systems at the probe tip.*

*2 *015-0437-00 Matched pair recommended*

*3 *Option 09 Mainframe*

*4 *Requires 1101/1101A Power Supply or other external source of power when used with 7854, 7603, 7633, 7623, or 7613.*

*5 *Bandwidths given for 10X switch position.*

*Nc = Not compatible*

*If there is no bandpass specified, the probe/plug-in combination is compatible but not recommended.*

## 7000 SERIES MAINFRAME/TIME BASE RECOMMENDATIONS

| **MAINFRAME** | | **R7103 7104** | **7904A R7903** | **7844/R 7834** | **7854** | **7704A R7704** | **7603/R** | **7623A/R** | **7613/R** |
|---|---|---|---|---|---|---|---|---|---|
| **TIME BASE** | **PERFORMANCE FEATURE** | • INDICATES RECOMMENDED COMBINATION | | | | | | | |
| **7B50A** | Single time base | | | | | | • | • | • |
| **7B53A** | Dual time base with mixed sweep | | | | | | • | | • |
| **7B53A Option 05** | 7B53A with TV sync triggering | | | | •*2 | | • | • | • |
| **7B80** | Single time base (used also as delayed time base) | | • | • | •*2 | • | | | |
| **7B85** | Single time base with delaying and Δ delay sweep function | | • | • | •*2 | •*1 | | | |
| **7B87** | Pretrigger and single shot digitizing | | | | • | | | | |
| **7B92A** | Dual time base with display switching | • | • | • | •*2 | •*1 | | | |
| **7B10** | Single time base (used also as delayed time base) | • | • | • | •*2 | • | | | |
| **7B15** | Single time base with delaying and Δ delay sweep function | • | • | • | •*2 | •*1 | | | |

*1 *No trace separation on R7704.*

*2 *Full capabilities of 7854 not achievable with this time base.*

## 7000 SERIES MAINFRAMES AND PLUG-INS DIMENSIONS AND WEIGHTS

| **Dimensions** | | **7612D** | **7912AD** | **7854*1** | **7104** | **R7103** | **7904A** | **R7903** | **7844** | **R7844** | **7834** | **7704A** | **R7704** | **7603** | **R7603** | **7633, 7623A, 7613** | **R7633, R7623A, R7613** | **Plug-Ins Single** | **Plug-Ins Double** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Width | mm | 483 | 483 | 305 | 305 | 483 | 305 | 483 | 305 | 483 | 305 | 305 | 483 | 221 | 483 | 221 | 483 | 7.1 | 140 |
| | in | 19.0 | 19.0 | 12.0 | 12.0 | 19.0 | 12.0 | 19.0 | 12.0 | 19.0 | 12.0 | 12.0 | 19.0 | 8.7 | 19.0 | 8.7 | 19.0 | 2.8 | 5.5 |
| Height | mm | 178 | 178 | 348 | 345 | 178 | 345 | 135 | 328 | 178 | 345 | 345 | 178 | 290 | 133 | 305 | 133 | 127 | 127 |
| | in | 7.0 | 7.0 | 13.7 | 13.6 | 7.0 | 13.6 | 5.3 | 12.9 | 7.0 | 13.6 | 13.6 | 7.0 | 11.4 | 5.3 | 12.0 | 5.3 | 5.0 | 5.0 |
| Depth | mm | 679 | 679 | 627 | 592 | 704 | 577 | 579 | 605 | 630 | 589 | 577 | 569 | 610 | 627 | 597 | 566 | 368 | 368 |
| | in | 26.8 | 26.8 | 24.7 | 23.3 | 27.7 | 22.7 | 22.8 | 23.8 | 24.8 | 23.2 | 22.7 | 22.4 | 24.0 | 24.7 | 23.5 | 22.3 | 14.5 | 14.5 |
| **Weights ≈** | | | | | | | | | | | | | | | | | | | |
| Net | kg | 25.0 | 22.7 | 20.4 | 19.8 | 20.0 | 16.9 | 12.3 | 16.3 | 15.0 | 16.1 | 13.6 | 20.0 | 13.6 | 13.6 | 13.6 | 14.5 | 0.9 | 4.1 |
| | lb | 55.0 | 50.0 | 45.0 | 43.6 | 44.0 | 37.2 | 27.0 | 36.0 | 33.0 | 35.5 | 30.0 | 44.0 | 30.0 | 30.0 | 30.0 | 32.0 | 2.0 | 9.0 |
| Shipping | kg | 42.1 | 32.6 | 28.1 | 25.4 | 30.9 | 21.4 | 23.6 | 21.3 | 28.5 | 21.3 | 19.5 | 35.0 | 20.8 | 28.2 | 19.0 | 28.2 | 2.3 | 5.4 |
| | lb | 93.0 | 72.0 | 62.0 | 56.0 | 68.0 | 47.0 | 52.0 | 47.0 | 63.0 | 47.0 | 43.0 | 77.0 | 46.0 | 62.0 | 42.0 | 62.0 | 5.0 | 12.0 |

*1 *Calculator dimensions and weights, width 277 mm (10.9 in), height 69 mm (2.7 in), depth 165 mm (6.5 in).*

## 7000 SERIES VERTICAL SYSTEM SPECIFICATIONS

| PLUG-IN AMPLIFIER | | 7A13 | 7A15A | 7A16A | 7A17 | 7A18A | 7A19 | 7A22 | 7A24 | 7A26 | 7A29 | 7A42 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PAGE | | 254 | 251 | 251 | 253 | 252 | 251 | 255 | 252 | 252 | 251 | 256 |
| Performance Feature | | Differential dc offset, high-freq CMRR amplifier | Low cost conventional input amplifier | Wide bandwidth conventional input amplifier | Low cost, easy to customize amplifier | Dual-channel amplifier | Wide bandwidth 50 Ω input amplifier | Dc-coupled, high-gain differential amplifier | Dual-channel 50 Ω amplifier | Dual-channel amplifier | Widest Bandwidth Single Channel | Four-channel Logic Triggered |
| Minimum Deflection Factor | | 1 mV/div | 5 mV/div (0.5 mV/div)*2 | 5 mV/div | 50 mV/div | 5 mV/div | 10 mV/div | 10 μV/div | 5 mV/div | 5 mV/div | 10 mV/div | 20 mV/div |
| Accuracy*1 Without Probe | | 1.5% | 2% | 2% | — | 2% | 3% | 2% | 2% | 2% | 2% | 3% |
| **7104 R7103** | BW | 105 MHz | 80 MHz | 225 MHz | 150 MHz | 75 MHz | 600 MHz | 1 MHz ± 10% | 400 MHz | 200 MHz | 1000 MHz | 350 MHz |
| 0 to 35°C | Tr | 3.4 ns | 4.4 ns | 1.6 ns | 2.4 ns | 4.7 ns | 0.6 ns | 350 ns ± 9% | 0.9 ns | 1.8 ns | 0.35 ns | 1.0 ns |
| **7904A R7903 7912AD*3,*7** | BW | 105 MHz | 80 MHz | 225 MHz | 150 MHz | 75 MHz | 500 MHz | 1 MHz ± 10% | 350 MHz | 200 MHz | 500 MHz | 300 MHz |
| | Tr | 3.4 ns | 4.4 ns | 1.6 ns | 2.4 ns | 4.7 ns | 0.8 ns | 350 ns ± 9% | 1.0 ns | 1.8 ns | 0.7 ns*8 | 1.2 ns |
| 0 to 30°C | SIG OUT BW | 100 MHz | 70 MHz | 140 MHz | 15 MHz | 70 MHz | 300 MHz | 1 MHz ± 10% | 140 MHz | 140 MHz | 300 MHz | NA |
| **7844/R** | BW | 100 MHz | 80 MHz | 200 MHz | 150 MHz | 75 MHz | 400 MHz*4 | 1 MHz ± 10% | 300 MHz | 180 MHz | 400 MHz | 275 MHz |
| 0 to 35°C | Tr | 3.5 ns | 4.4 ns | 1.8 ns | 2.4 ns | 4.7 ns | 0.9 ns | 350 ns ± 9% | 1.2 ns | 1.9 ns | 0.9 ns | 1.3 ns |
| **7854*6 7834** | BW | 100 MHz | 80 MHz | 200 MHz | 150 MHz | 75 MHz | 400 MHz*4 | 1 MHz ± 10% | 300 MHz | 180 MHz | 400 MHz | 275 MHz |
| 0 to 35°C | Tr | 3.5 ns | 4.4 ns | 1.8 ns | 2.4 ns | 4.7 ns | 0.9 ns | 350 ns ± 9% | 1.2 ns | 1.9 ns | 0.9 ns | 1.3 ns |
| **7704A Opt 09** | BW | 100 MHz | 75 MHz | 170 MHz | 150 MHz | 75 MHz | 250 MHz*5 | 1 MHz ± 10% | 200 MHz | 170 MHz | 250 MHz | 180 MHz |
| | Tr | 3.6 ns | 4.7 ns | 2.1 ns | 2.4 ns | 4.7 ns | 1.5 ns | 350 ns ± 9% | 1.8 ns | 2.1 ns | 1.5 ns | 1.9 ns |
| 0 to 30°C | SIG OUT BW | 60 MHz | 55 MHz | 70 MHz | 15 MHz | 55 MHz | 80 MHz | 1 MHz ± 10% | 70 MHz | 70 MHz | 80 MHz | NA |
| **7704A** | BW | 95 MHz | 75 MHz | 160 MHz | 150 MHz | 75 MHz | 200 MHz | 1 MHz ± 10% | 200 MHz | 150 MHz | 200 MHz | 175 MHz |
| 0 to 50°C | Tr | 3.8 ns | 4.7 ns | 2.2 ns | 2.4 ns | 4.7 ns | 1.8 ns | 350 ns ± 9% | 1.8 ns | 2.4 ns | 1.8 ns | 2.0 ns |
| | SIG OUT BW | 60 MHz | 55 MHz | 70 MHz | 15 MHz | 55 MHz | 80 MHz | 1 MHz ± 10% | 70 MHz | 70 MHz | 80 MHz | NA |
| **R7704** | BW | 95 MHz | 75 MHz | 150 MHz | 150 MHz | 75 MHz | 175 MHz | 1 MHz ± 10% | 160 MHz | 140 MHz | 175 MHz | 150 MHz |
| | Tr | 3.8 ns | 4.7 ns | 2.4 ns | 2.4 ns | 4.7 ns | 2.0 ns | 350 ns ± 9% | 2.2 ns | 2.5 ns | 2.0 ns | 2.3 ns |
| 0 to 50°C | SIG OUT BW | 60 MHz | 50 MHz | 60 MHz | 15 MHz | 50 MHz | 65 MHz | 1 MHz ± 10% | 60 MHz | 60 MHz | 65 MHz | NA |
| **7603/R 7633/R** | BW | 75 MHz | 65 MHz | 100 MHz | 100 MHz | 75 MHz | 100 MHz | 1 MHz ±10% | 100 MHz | 100 MHz | 100 MHz | 100 MHz |
| 0 to 50°C | | | | | | | | | | | | |
| **7623A/R 7613/R** | Tr | 4.8 ns | 5.4 ns | 3.5 ns | 3.5 ns | 4.7 ns | 3.5 ns | 350 ns ± 9% | 3.5 ns | 3.5 ns | 3.5 ns | 3.5 ns |
| 0 to 50°C | | | | | | | | | | | | |
| | SIG OUT BW | 55 MHz | 50 MHz | 60 MHz | 15 MHz | 50 MHz | 65 MHz | 1 MHz ± 10% | 60 MHz | 60 MHz | 65 MHz | NA |
| **7612D*7** | BW | 65 MHz | 60 MHz | 80 MHz | 80 MHz | 65 MHz | 80 MHz | 1 MHz ± 10% | 80 MHz | 80 MHz | 80 MHz | 80 MHz |
| 0 to 40°C | Tr (Calculated) | 6.0 ns | 6.7 ns | 5.0 ns | 5.0 ns | 6.0 ns | 5.0 ns | 350 ns ± 9% | 5.0 ns | 5.0 ns | 5.0 ns | 5.0 ns |

**1 Accuracy percentages apply to all deflection factors. Plug-in gain must be set at the deflection factor designated on each plug-in. When a probe is used, the gain must be set with the calibration signal applied to the probe tip. The calibration signal is supplied by an external calibrator whose accuracy is within 0.25%.*

**2 Obtained with 10X gain at reduced bandwidth of 10 MHz.*

**3 Refer to Transient Digitizer, 7912AD not available with signal outputs.*

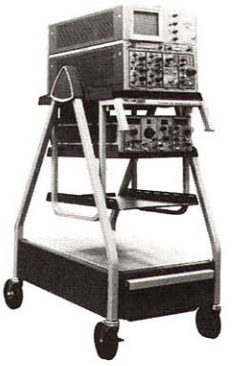
**4 Bandwidth is 325 MHz at 10 mV/div.*

**5 Bandwidth is 200 MHz at 10 mV/div.*

**6 Bandwidth with equivalent time sampling and time display only.*

**7 Fully programmable mainframe. 7A16P Programmable Amplifier recommended. 7A16P provides 200 MHz, 1.8 ns in 7912AD and 80 MHz, 5.0 ns in 7612D, see page 342.*

**8 R7903 with 7A29 Tr is 0.8 ns.*



**TEK Lab Cart Model 3**

Model 3 Lab Cart accepts all 7000 Series oscilloscopes. A lockable drawer for storage and a movable shelf for additional instrumentation are included. The shelf accepts TM 500 Test and Measurement instruments, 5000 Series oscilloscopes, or 400 Series oscilloscopes. (A tray for the 7854 keyboard is also available as a modified product.)

For full details see SCOPE-MOBILE® Cart section, page 430.

## SUMMARIZED CAMERA CHARACTERISTICS

| RECOMMENDED CAMERA | 7000 SERIES OSCILLOSCOPES | PERFORMANCE FEATURES AND BENEFITS | LENS | | | | FILM BACKS | | PAGE |
|---|---|---|---|---|---|---|---|---|---|
| | | | MAXIMUM RELATIVE APERTURE | MAG | RELATIVE SPEED*1 | FIELD OF VIEW (with 3.25 x 4.25 in Polaroid Film except where noted) | STANDARD BACK | OPTIONAL AND INTERCHANGEABLE | |
| C-51P*2 | 7904A, R7903, 7844, 7854 R7704, 7704A | Fastest writing speed with 0.5 mag lens | f/1.2 | 0.5 | 3.0 | 8 x 10 cm/ 3.15 x 3.93 in | Polaroid Pack | 4 x 5 in Graflok*3 (C-51G) | 427 |
| C-53P*2 | All except 7603, R7603 | General-pupose with 0.85 mag lens | f/1.9 | 0.85 | 1.0 | 8 x 10 cm/ 3.15 x 3.93 in | Polaroid Pack | 4 x 5 in Graflok*3 (C-53G) | 427 |
| C-59AP*2 | 7603, R7603 | General-pupose for 6½ in CRT's | f/2.8 | 0.67 | 0.65 | 10.2 x 12.7 cm/ 4 x 5 in | Polaroid Pack | 4 x 5 in Graflok*3 (C-59AG) | 428 |
| C-5C C-7 | All except 7603/R7603 | Low cost for repetitive waveforms | f/16 | 0.67 or 0.85 selectable | 0.02 | 9.76 x 12.2 cm | Polaroid Pack | None | 425 |
| C-5C Option 01 C-7 Option 01 | 7603/R7603 | | | | | | | | |
| C-4 Option 02 | All 7000 Series | Low Cost Easy to use Hand Held | F/4.5 | 0.70 | 0.18 | 10.4 x 13.5 cm | Polaroid Pack | none | 422 |

*1 *Relative light-gathering power.*
*2 *C-50 Series Camera Adaptor, part number 016-0249-03, included with camera. For full details see camera section, page 421.*
*3 *Requires optional film holder, i.e., 4 x 5 in, 120 mm, 70 mm, or sheet film.*

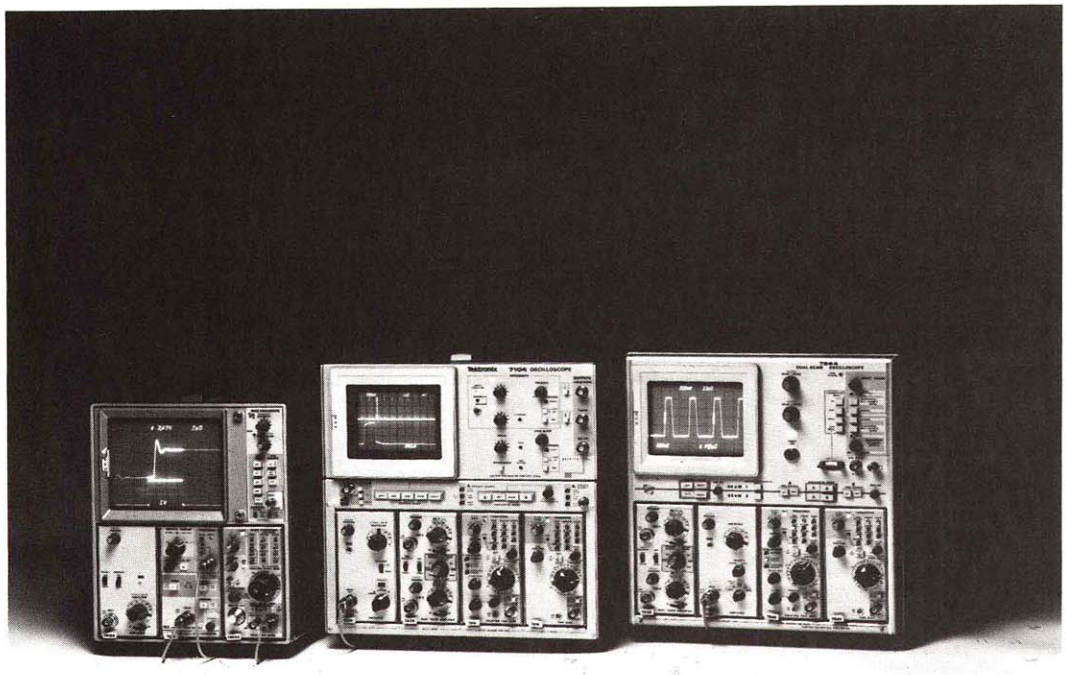
## CURRENT APPLICATION NOTES FOR 7000 SERIES*1

| Title | Featuring | Part No |
|---|---|---|
| PULSE ECHO MEASUREMENTS with digital accuracy | 7603/7A22/7D15/7B53A Timing measurements between nonadjacent pulses. Ultrasonic transducers | 42AX-3681-1 |
| 7A42 Invalid Logic Levels | 7A42 Logic triggered amplifier. Checking Logic levels | 42W-5629 |
| 7A42 Bus Contention | 74A42 Microprocessor Bus Contention Measurement | 42W-5630 |
| 7A42 Advanced Trigger Application | 7A42 Complex signals are easily measured with the logic trigger vertical system | 42W-5588 |
| X-Y DISPLAYS with Interval Timing for Measuring SOA | 7D15/7A18/7A22 X-Y power dissipation measurements | 42AX-3957 |
| DAC MEASUREMENTS: The sampling oscilloscope approach | 7S14/7D12/M2/7B92A/7904 Measuring DAC (digital analog converter settling time | 42AX-3632-1 |
| SCR GATING WAVEFORM MEASUREMENTS with high-resolution digital accuracy | 7D12/M2/7A16A (four compartment mainframes) SCR measurements. Absolute and relative (two point) voltage monitoring | 42AX-2693-1 |
| Accurate Radar Pulse Measurements | 7D11 The measurement of radar pulse delay time is given as an example of 7D11 operation | AX-2659-3 |
| Measuring time interval between non-adjacent digital word train pulses or multiecho radar pulses | 7D15 Demonstrates the ability of the 7D15 to measure the time between adjacent pulses with digital counter accuracy | 42W-2680-3 |
| The 7D20 Programmable Digitizer: Proforming a Wide Range of Measurement Tasks Easier, Faster, and more Accurately. | 7D20 application examples including ultrasonic testing, monitoring nerve activity, measuring pulse jitter, and SOA analysis of power devices. | 42W-5085 |

| Title | Featuring | Part No |
|---|---|---|
| Measuring memory core I/O signals with digital accuracy | 7000 Series digital plug-ins Demonstrates how digital plug-ins can be used to make accurate pulse parameter measurements both of amplitude and pulse timing | 42AX-2686-1 |
| Measuring disc drive time and access voltages with Tektronix 7000 Series Digital Plug-ins | 7000 Series digital plug-ins Use a single CRT display to perform both digital and analog analysis of complex waveforms | 42AX-2687-2 |
| MEASUREMENT VARIETY An Engineering challenge featuring the 7854 | 7854/Waveform Calculator Demonstrating basic operation, application software for percent overshoot, data monitoring and histogram. | 42AX-4281 |
| GPIB COMMUNICATION with the 7854 | 7854/4052 and 7854/4924 Types of I/O transfers, transmission formats, and operational software in TEK Basic compatible with any 4050 Series computer | 42AX-4416-1 |
| Pulse and digital timing measurements—a better technique | 7B80/7B85 General overview of the operation of the 7B85 and 7B80 delta-time measurement plug-ins | 42AX-3379-1 |
| Using storage to find troublesome logic glitches | 7633 Shows how the 7633 storage oscilloscope can be used to capture and evaluate glitches | 42AX-3085 |
| Variable persistence storage applications | 7613/5441 Describes various applications for variable persistence storage oscilloscopes | 42AX-3198 |
| Automated TDR Testing | Made easy with the 7854 oscilloscope/ 7S12 sampler plug-in | 42W-5334-1 |
| Bistable storage applications | Tektronix Storage Oscilloscopes. Describes various applications for bistable storage oscilloscopes | 42AX-3199 |

*1 *Check with your local sales office for availability and other application notes not listed.*

# 7000 SERIES NONSTORAGE MAINFRAMES



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**7603/R7603** 100 MHz General Purpose ..... **240**
**7844/R7844** 400 MHz Dual Beam ..... **242**

A high performance instrument system begins with the basic oscilloscope building block—the 7000 Series mainframe. Each mainframe consists of a cathode-ray tube, a power supply, electron beam deflection systems, and the switching circuitry necessary to integrate a versatile and complete measurement system.

The Tektronix 7104 and the *NEW* R7103 are 1 GHz oscilloscopes featuring the fastest risetime (350 ps) and highest photographic writing speed (20 cm/ns) available today.

Choose from a variety of features, including bandwidth, photographic writing speed, dual-beam, alphanumeric displays, rack-mounting, and three- or four-plug-in flexibility.

NEW

## 7104/*NEW* R7103

**Ultra High Photographic Writing Speed—at Least 20 cm/ns**

**1 GHz at 10 mV/div**

**350 ps Risetime**

**200 ps/div Fastest Calibrated Sweep Rate**

**Horizontal Bandwidth 350 MHz**

**Phase Compensation Option—Phase Matching to 250 MHz (7104 Only)**

**CRT Readout**

**Seven Inch Rackmount (R7103 Only)**

### TYPICAL APPLICATIONS

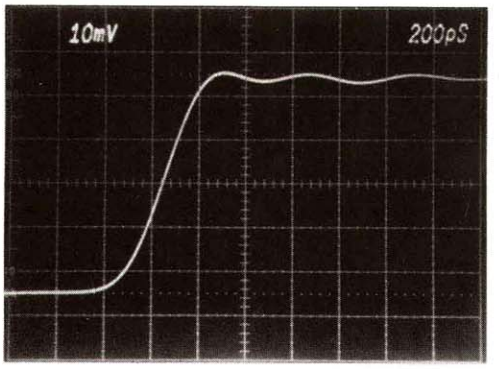
- **High Speed Semiconductor Design**
- **Laser and High Energy Research**
- **Digital Communications**

The capabilities of the 7104 and the seven inch rackmount R7103 are of substantial value in numerous high technology environments. The 7104/R7103 have both the highest writing speed and highest bandwidth available in a general-purpose oscilloscope today.

The 7104/R7103's outstanding writing speed means unsurpassed single-shot capability, with trace brightness about **one-thousand** times that of conventional oscilloscopes. Any single-shot signal within the 1 GHz bandwidth can be seen directly on the CRT in average room light. Also, single-shot photography is now simple and straightforward, using standard oscillographic cameras and film without high-speed enhancement techniques.

It is by no means unusual to see 250 MHz data rates and 900 MHz analog frequencies outside the lab and on the production line. In digital design, too, anomalies such as ringing and overshoot can only be dealt with by evaluating the signal's analog characteristics.

You can capture the fastest transients without expensive high-speed film or other time consuming and complex techniques like fogging or reducing the scan. In fact, you can see those signals on the CRT, and eliminate costly time consuming photographs.



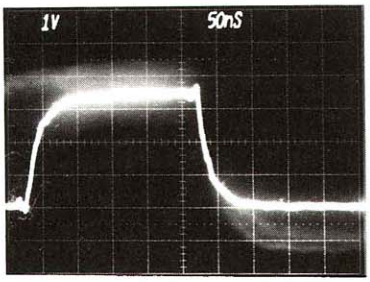

*With its sweep speed of 200 ps/div, the 7104/R7103 clearly shows a single-shot, 350-ps step, five divisions in amplitude.*

Horizontal bandwidth of 350 MHz, with the X-Y phase compensation Option 02 (7104 only), gives accurate X-Y displays to 250 MHz. Designers can now directly obtain V-I curves for high-speed switching power supply evaluation or monitor performance of digital communication systems using phase constellation displays.

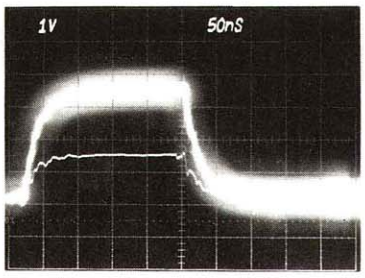
*The R7103 requires only 7-inches of rack height in a standard 19 inch rack. It is fan-cooled and comes complete with slideout chassis tracks.*

NEW

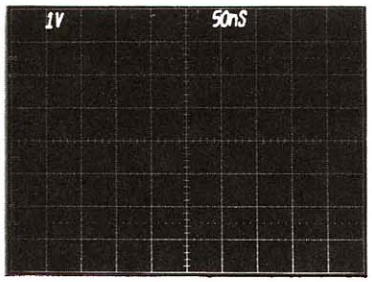
# SEE WHAT YOU COULD NEVER SEE BEFORE.



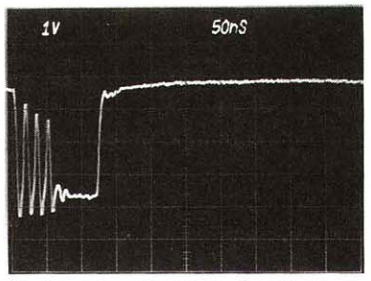

***Before** — A pulse train on a TEK 7904A doesn't reveal the low-level glitch occurring every ten-thousandth pulse. (The TEK 7904A was previously the world's fastest-writing-rate scope.)*



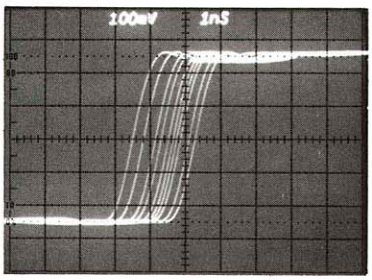

***After** — The same pulse train viewed directly on the 7104/R7103, with one-thousand times the brightness of conventional scopes. The researcher can now analyze the pulse with the naked eye and take pictures with ease.*



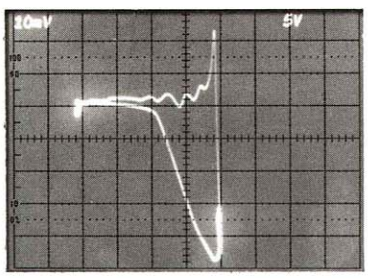

***Before** — Low rep-rate pulse is invisible on a conventional oscilloscope.*



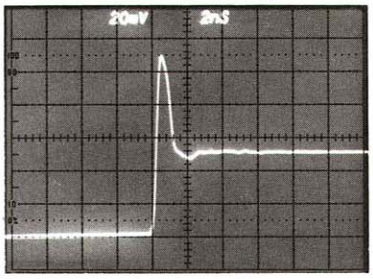

***After** — The same pulse as seen on the 7104/R7103 readily indicates that the problem is input signal bounce.*



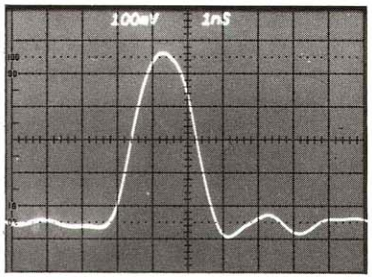

*A digital circuit that shows no jitter on a conventional oscilloscope is found to have a 2.0 ns jitter when viewed with the distinct image viewing capability of the 7104/R7103.*




*The transient load line of a fast switching transistor in a power supply prototype (switching time=10 ns) is easily measured for compliance with safe operating area. (Horizontal=V; vertical=I).*




*Circuit faults such as high frequency pulse overshoot and ringing can easily be observed with the 7104/R7103's 1 GHz bandwidth.*




*View of a single clocking pulse 0.8 ns rise and 2 ns pulse width.*

## CHARACTERISTICS

The following characteristics are common to the 7104 and the R7103, except those noted under the R7103.

### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins (except 7D01, 7D02, and 7D20). Bandwidth determined by mainframe and plug-in unit. See page 231.
**Vertical Display Modes** — Left, Alt, Add, Chop, Right.
**Chopped Mode** — Rep rate is ≈1 MHz.
**Vertical Trace Separation** — Operative when any vertical signal is displayed with both A and B time bases. Positions B trace at least four divisions above and below A trace (7104 only).
**Delay Line** — Permits viewing leading edge of displayed waveform.

### HORIZONTAL SYSTEM

**Channels** — Two right-hand plug-in compartments; compatible with the time bases of the 7B10 and 7B80 Series and the 7B50A and 7B92A. The 7B50 Series (except the 7B50A), the 7B70 Series and the 7B92 (non-A) are not recommended. 7000 Series vertical amplifiers and specialized plug-ins (except 7D01, 7D02 and 7D20) may also be used.
**Horizontal Display Modes (7104 Only)** — A, Alt, Chop, B.
**Fastest Calibrated Sweep Rate** — 200 ps/div with the 7B10 or 7B15.
**Chopped Mode (7104 Only)** — Rep rate is ≈200 kHz.
**Bandwidth** — Dc to 350 MHz. With delay compensation (7104 Option 02 using 7A19s or 7A29s, at least one of which has the Variable Delay Option, B Horizontal compartment only), within 2° from dc to 50 MHz after adjusting variable delay for balance at 35 MHz. Phase balance can be obtained at any frequency up to 250 MHz. Phase shift is within 2° from dc to 50 kHz without delay compensation.

### CRT AND DISPLAY FEATURES

**CRT** — Internal 8 x 10 division (0.85 cm/div) graticule with variable illumination. Accelerating potential is 12.5 kV with GH (P31) phosphor standard.
**Readout and Graticule Modes** — Each continuous or pulsed (pulse source selecton by front panel controls: +Gate, external, manual). The pulsed graticule is on for ≈0.5 s.
**Mininum Photographic Writing Speed (using Polaroid Film Type 107, 3000 ASA w/out Film Fogging)** — 20 cm/ns (w/o filter). Phosphor: GH (P31) standard. Camera: Tektronix C-53, f/1.9, 1:0.85 lens.
**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.
**Beam Finder** — Limits display within graticule area.
**External Z-Axis Input** — 2 V p-p for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.

### CALIBRATOR

**Voltage Output** — Squarewave positive-going from ground. Ranges are 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%; rep rate is 1 kHz within 0.25%.
**Current Output** — 40 mA rectangular waveshape with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

### EMC CAPABILITY (7104 OPTION 03 and R7103)

Meets requirements of MIL-STD-461B, when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.

### OUTPUTS/INPUTS

**+Sawtooth** — Output voltage is 50 mV/div (±5%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.
**+Gate** — Positive-going rectangular waveform. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Output R is ≈950 Ω.
**Vertical Signal Out** — Output voltage is 25 mV/div into 50 Ω, 0.5 V into 1 MΩ. Bandwidth depends upon vertical plug-in. Output R is ≈950 Ω.
**Camera Power** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series camera.
**Probe Power** — Two rear-panel connectors provide correct operating voltages for two active probes.
**Single-Sweep Ready Indicator** — +5 V, rear panel BNC output for single sweep ready indication.
**Graticule/Readout, Single-Shot** — Ground closure, rear panel BNC input initiates one frame of CRT read-out and the Grat Illum is illuminated for ≈0.5 s.
**External Single-Sweep Reset** — Ground closure, rear panel BNC, provides input to reset sweep.

### POWER REQUIREMENTS

**Line Voltage Ranges** — 90 V to 132 V ac and 180 V to 250 V ac.
**Line Frequency** — 48 Hz to 440 Hz.
**Maximum Power Consumption** — 215 W, 3.3 A at 90 V line, 60 Hz.

## CHARACTERISTICS (R7103)

The following characteristics are unique to the R7103, other characteristics are common with the 7104.

### HORIZONTAL SYSTEM

**Single Channel** — Right-hand plug-in compartment compatible with time bases of the 7B10 and 7B80 Series and the 7B50A and 7B92A. The 7B50 Series (except 7B50A), the 7B70 Series and the 7B92 (non-A) are not recommended. 7000 Series vertical amplifiers and specialized plug-ins (except 7D01, 7D02, and 7D20) may also be used.
**Bandwidth** — Dc to 350 MHz. Phase shift between vertical and horizontal deflection systems is within 2° from dc to 50 kHz.

**Included Accessories** — Power cord; instruction manual.
**Dimensions and Weights** — See page 230.
**For Recommended Cameras** — See page 421.
**For Recommended Plug-ins** — See pages 230-231.
**For Recommended Probes** — See pages 230 and 440.

## ORDERING INFORMATION

**(PLUG-INS NOT INCLUDED)**

**7104** Oscilloscope ..... **$22,705**
**Option 02** — X-Y Horizontal Comp ..... **+$300**
**Option 03** — EMC Capability ..... **+$375**
**R7103** Oscilloscope ..... **$22,920**

### CONVERSION KITS (7104)

**EMC Modification** — Order 040-0965-00 ..... **$520**

### INTERNATIONAL POWER CORDS AND PLUG OPTIONS (7104 and R7103)

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

## Plug-in Compatibility

**7A29** — Vertical amplifier, 50 Ω input, dc to 1 GHz; 10 mV/div to 1 V/div vertical sensitivity ..... **$2,855**
**7A42** — Four channel, 350 MHz bandwidth vertical amplifier with Boolean logic triggering capabilities ..... **$6,070**
**7B10** — Delayed time base with 200 ps/div to 0.2 s/div calibrated sweep speed; triggering up to 1 GHz ..... **$2,380**
**7B15** — Delaying time base with 200 ps/div to 0.2 s/div calibrated sweep speed; triggering up to 1 GHz; capable of Δtime measurements in conjunction with 7B10 ..... **$2,695**
**7B92A** — Dual time base with 500 ps/div to 0.2 s/div calibrated sweep speed; triggering up to 500 MHz; capable of delay time measurements ..... **$3,575**

**The 7D01, 7D02 Logic Analyzers and 7D20 Digitizer are not recommended for use in the 7104/R7103 mainframe. Such use will void the 7104/R7103 warranty.**

NONSTORAGE OSCILLOSCOPES

## 7904A/R7903

- 500 MHz at 10 mV/div
- 700 ps Risetime (7904A)
- 500 ps/div Fastest Calibrated Sweep Rate
- Greater Than 4 cm/ns Writing Speed with Optional CRT
- CRT Readout
- Over 30 Compatible Plug-ins
- 900 MHz FET Probe Available

## TYPICAL APPLICATIONS

- **Digital Design**
- **Radar**
- **Laser Research**

The 7904A and 5.25 inch rackmount R7903 are high bandwidth, general-purpose oscilloscopes. The 7A29 Amplifier/7904A mainframe attains 500 MHz at 10 mV/div. A 7A29 variable delay option allows for the matching of signal transit times of two plug-ins and their probes to better than 50 ps.

The P6201 1X FET probe gives you high impedance and wide bandwidth. It has a 900 MHz bandwidth by itself, and in combination with the 7A29/7904A, it provides a system bandwidth of 450 MHz at 10 mV.

The CRT, the major contributor to the performance of the 7904A and R7903, has good visual brightness and an 8 cm x 10 cm display area.

For high photographic writing speed applications, Option 13 provides BE (P11) phosphor and a reduced scan CRT yielding greater than 4 cm/ns photographic writing rate. For comparison of 7000-Series photographic writing rates, see page 221.

## CHARACTERISTICS

The following characteristics are common to the 7904A and R7903, except those noted under the R7903.

### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins. Bandwidth determined by mainframe and plug-in unit. See page 231.

**Modes of Operation** — Left, Alt, Add, Chop, Right.

**Chopped Mode** — Rep rate is ≈1 MHz.

**Trace Separation Range (Dual-Sweep Modes)** — The B trace can be positioned four divisions above or below the A trace (7904A only).

**Delay Line** — Permits viewing leading edge of displayed waveform when using 7B80 and 7B90 Series time bases. 7B50 Series not recommended.

### HORIZONTAL SYSTEM

**Channels** — 7904A: Two right-hand plug-in compartments compatible with 7B80 and 7B90 Series time bases. R7903: One right-hand plug-in compartment compatible with 7B80 and 7B90 Series time bases. 7904A and R7903: 7000 Series vertical amplifiers and specialized plug-ins may also be used.

**Fastest Calibrated Sweep Rate** — 500 ps/div with the 7B92A.

**Chopped Mode (7904A Only)** — Rep rate is ≈200 kHz.

**X-Y Mode (7904A Only)** — Phase shift is within 2° from dc to 35 kHz without phase correction (dc to 1 MHz with phase correction, Option 02) between vertical and horizontal channels. Bandwidth is dc to at least 1 MHz.

### CRT AND DISPLAY FEATURES

**Standard** — Internal 8 cm x 10 cm graticule with variable illumination. Accelerating potential is 24 kV with GH (P31) phosphor standard.

**Option 13, Maximum Brightness CRT with Reduced Area** — Internal 4 cm x 5 cm graticule with variable illumination. Accelerating potential is 24 kV with BE (P11) phosphor.

**Option 78, BE (P11) Phosphor.**

**TYPICAL PHOTOGRAPHIC WRITING SPEED*¹**

| CRT | Camera | Lens | Writing Speed cm/ns |
|---|---|---|---|
| Option 78 8 cm x 10 cm | C-51P | f/1.2 1:0.5 | 2.5 |
| Option 13 4 cm x 5 cm | | | 4 |

*¹ *Using the optional BE (P11) phosphor and Polaroid Type 612 20,000 ASA Film without film fogging.*

In typical applications, GH (P31) phosphor standard has approximately one-half the writing speed of BE (P11) phosphor. The writing speed can be increased by using controlled film fogging with a writing speed enhancer (camera accessory).

**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

**Beam Finder** — Limits display within graticule area.

**External Z-Axis Input** — 2 V p-p for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.

*The R7903 requires only 5.25 inches of rack height in a standard 19 inch rack. It is fan-cooled and comes complete with slide-out chassis tracks.*

#### CALIBRATOR

**Output Waveshape** — Rectangular positive-going from ground, 1 kHz (±0.25%).

**Voltage Ranges** — 40 mV, 0.4 V, 4 V into an open circuit. 4 mV, 40 mV, 0.4 V into 50 Ω.

**Current Output** — 40 mA.

#### OUTPUTS/INPUTS

**+Sawtooth** — Sawtooth starts 1 V or less from ground (into 1 MΩ). Front-panel selectable from A or B horizontal. Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.

**+GATE** — Positive-going rectangular waveform derived from A, B, or Delayed Gate, front-panel selectable. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Risetime is 5 ns or less into 50 Ω.

**Vertical Signal Out** — Selected by B Trigger Source switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Bandwidth depends upon vertical plug-in. See the Vertical System Specifications Chart on page 231. Output R is ≈950 Ω.

**Camera Power** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series cameras.

**Probe Power** — Two rear-panel connectors provide correct operating voltages for two active probes.

#### POWER REQUIREMENTS

**Line Voltage Ranges** — 90 V to 132 V ac and 180 V to 250 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 210 W, 3.5 A at 90 V line, 60 Hz.

## CHARACTERISTICS (R7903)

The following characteristics for the R7903 are in addition to or in lieu of those listed previously.

#### HORIZONTAL SYSTEM

**Single Channel** — Right-hand plug-in compartment compatible with time bases of 7B80 and 7B90 Series. 7000 Series vertical amplifiers and specialized plug-ins may also be used.

**Fastest Calibrated Sweep Rate** — 500 ps/div with the 7B92A.

#### CRT AND DISPLAY FEATURES

**Option 01** — No CRT readout (R7903 Only). (CRT readout can be added later with Conversion Kit 040-0605-03.)

**Option 10, Pulsed Graticule (R7903 Only)** — Provides a means of pulsing the graticule lights at a preset level coincident with a single-shot event in one exposure. The graticule lights may be pulsed by the event, an external ground closure, or a front panel pushbutton. If the mainframe is equipped with CRT readout, Option 10 provides additional controls and inputs for CRT readout pulsed operation.

#### CALIBRATOR
#### (NOT AVAILABLE WITH OPTION 10)

**Voltage Ranges** — 4 mV, 40 mV, 0.4 V, 4 V into an open circuit; 4 mV, 40 mV, 0.4 V into 50 Ω.

**Current Output** — 40 mA rectangular waveshape with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

#### OUTPUTS/INPUTS
#### (STANDARD)

**+Sawtooth** — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.

**+Gate** — Positive-going rectangular waveform derived from Main or Auxiliary Gate. Output voltage 0.5 V (±10%) into 50 Ω. 10 V (±10%) into 1 MΩ. Risetime is 7 ns or less into 50 Ω. Output R is ≈950 Ω.

**Vertical Signal Out** — Selected by Trigger Source switches. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Bandwidth depends upon vertical plug-in. See the Vertical System Specifications Chart on page 231. Output R is ≈950 Ω.

**Single-Sweep Ready Output** — +5 V, rear panel BNC output, for single-sweep ready indication.

**External Single-Sweep Reset** — Ground closure, rear panel BNC, provides input to reset sweep.

**CRT Readout** — Inhibit: Ground closure, rear panel BNC input locks out CRT readout. Not available with Option 10. Single-Shot: Ground closure, rear panel BNC input initiates one frame of CRT readout. Not available with Option 10 separately, but in combination with the pulsed graticule input.

**Probe Power** — Two front-panel connectors provide correct operating voltages for two active probes. Not available for R7903 Option 10.

#### OUTPUTS/INPUTS OPTIONS

**Option 10, Pulsed Graticule** — No CRT readout single-shot input, CRT readout inhibit input, calibrator, and probe power. Single-shot graticule and CRT readout (ground closure) rear-panel BNC input is added. Initiates one frame of CRT readout and pulses graticule. CRT readout inputs are not functional with Option 01.

#### POWER REQUIREMENTS

**Line Voltage Ranges** — 90 V to 132 V ac and 180 V to 264 V ac.

**Maximum Power Consumption** — 160 W, 2 A at 115 V line, 60 Hz.

#### INCLUDED ACCESSORIES (7904A)

Power Cord; instruction manual.

#### INCLUDED ACCESSORIES (R7903)

Test adaptor (012-0092-00); two 18 in test leads (012-0087-00); rack-mounting hardware; power cord; instruction manual.

**Dimensions and Weights** — See page 230.

**For Recommended Cameras** — See page 421.

**For Recommended Plug-ins** — See pages 230-231.

**For Recommended Probes** — See pages 230 and 440.

## ORDERING INFORMATION

#### (PLUG-INS NOT INCLUDED)
#### (7904A AND R7903)

**7904A** Oscilloscope ..... **$9,085**

**R7903** Oscilloscope ..... **$8,780**

**Option 03** — EMC Capability ..... **+$375**

**Option 13** — Maximum Brightness 4 cm x 5 cm CRT Display with BE (P11) Phosphor ..... **+$600**

**Option 78** — BE (P11) Phosphor ..... **+$100**

#### OPTION (7904A)

**Option 02** — X-Y Horizontal Comp ..... **+$250**

#### OPTIONS (R7903)

**Option 01** — Without CRT Readout ..... **−$350**

**Option 10** — Pulsed Graticule ..... **+$250**

#### CONVERSION KITS (7904A)

**X-Y Horizontal Comp** — Order 040-0606-00 ..... **$390**

**EMC Capability** — Order 040-0570-00 ..... **$375**

#### CONVERSION KITS (R7903)

**CRT Readout** — Order 040-0605-03 ..... **$650**

**EMC Capability** — Order 040-0647-00 ..... **$374**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS
#### (7904A AND R7903)

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

**Option A5** — Switzerland 220 V/10 A, 50 Hz

**Tektronix offers service training classes on the 7904A General Purpose Oscilloscope. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.**

## 7704A/R7704

**Dc to 200 MHz with Optimum Pulse Response**

**1.8 ns Risetime**

**Dc to 250 MHz Bandwidth (Option 09)**

**Greater Than 15 cm/ns Enhanced Writing Speed with Optional CRT and WSEN**

**CRT Readout**

## TYPICAL APPLICATIONS

- **Communications**
- **Digital Design**
- **Component Testing**

The 7704 Family is a wide bandwidth general-purpose oscilloscope measurement system.

The 7704A offers you a choice of bandwidth performances to optimize the oscilloscope for your type of application. In the standard model, pulse aberrations are minimized while giving you a bandwidth of 200 MHz. For higher frequency applications, Option 09 provides a bandwidth of 250 MHz. The R7704 offers a 175 MHz bandwidth.

For high writing speed applications, Option 13 provides BE (P11) phosphor and a reduced scan CRT yielding >15 cm/ns photographic writing rate with the Tektronix C-51 Camera and writing speed enhancer (described on pages 422 and 423). For a comparison of 7000-Series photographic writing rates see page 221.

## CHARACTERISTICS

The following characteristics are common to the 7704A and the R7704, except those noted under the R7704.

### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins. Bandwidth determined by mainframe and plug-in unit. See Vertical System Specifications Chart on page 231.

**Option 09, Bandwidth Change (250 MHz)** — 7704A vertical circuit performance is adjusted to extend frequency response to 250 MHz at 20 mV/div (upper −3 dB) when 7A29 is used. Provides additional performance for those working in this frequency domain.

**Modes of Operation** — Left, Alt, Add, Chop Right.

**Chopped Mode** — 7704A, rep rate is internally selectable, ≈100 kHz or 1 MHz; R7704, fixed at ≈1MHz.

**Trace Separation Range (Dual-Sweep Modes)** — The B trace can be positioned above or below the A trace.

**Delay Line** — Permits viewing leading edge of waveform.

### HORIZONTAL SYSTEM

**Channels** — Two right-hand plug-in compartments; compatible with all 7000 Series plug-ins.

**Fastest Calibrated Sweep Rate** — 2 ns/div with 7B80 or 7B90 Series.

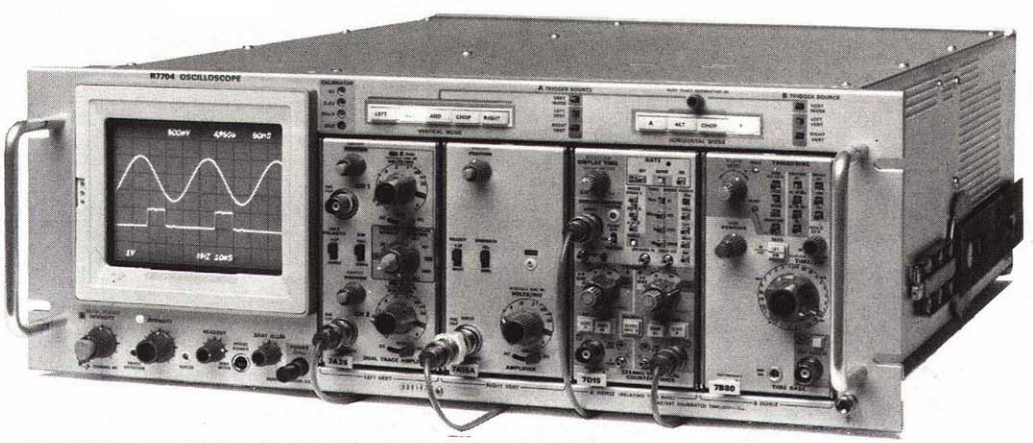
**Chopped Mode (Between Horizontal Plug-ins)** — Rep rate is internally selectable, ≈20 kHz or 200 kHz.

**X-Y Mode** — Phase shift is within 2° from dc to 50 kHz (7704A) between vertical and horizontal channels. Frequency response at 10% down is dc to at least 3 MHz.

### CRT

**Standard** — Internal 8 cm x 10 cm graticule with variable illumination. Accelerating potential is 24 kV with GH (P31) phosphor standard.

**Option 01** — No CRT readout. (CRT readout can be added later with conversion kit 040-0613-04.)



*The R7704 requires 7 inches of rack height and offers 175 MHz bandwidth.*

**Option 13, Maximum Brightness CRT with Reduced Area (7704A Only)** — Internal 4 cm x 5 cm graticule with BE (P11) phosphor. Accelerating potential is 24 kV.

**Option 78, BE (P11) Phosphor.**

**TYPICAL PHOTOGRAPHIC WRITING SPEED*1**

| CRT | Camera | Lens | Writing Speed cm/ns |
|---|---|---|---|
| Option 78 8 cm x 10 cm | C-51P | f/1.2 1:0.5 | 2 |
| Option 13 4 cm x 5 cm | | | 4 |

**1 Using the optional BE (P11) phosphor and Polaroid Type 612 20,000 ASA Film without film fogging.*

**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

**Beam Finder** — Limits display within graticule area and unblanks CRT.

**External Z-Axis Input** — 2 V p-p for full intensity range, A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc-coupled.

**High Speed Input** — Minimum pulse width to blank trace is 3.5 ns at 60 V; 60 V p-p for full intensity range from dc to 100 MHz. A positive signal blanks the trace; input R is 18 kΩ within 20%. Maximum input voltage is 60 V (dc + peak ac) and p-p ac.

**OUTPUTS/INPUTS**

**+Sawtooth** — Sawtooth starts 1 V or less from ground (into 1 MΩ). Internally selectable from A or B horizontal. Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is 950 Ω nominal.

**+Gate** — Positive-going rectangular waveform derived from A, B, or Delayed Gate, internally selectable. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Risetime is 20 ns or less into 50 Ω. Output R is 950 Ω nominal.

**Vertical Signal Out** — Selected by B Trigger Source switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. The bandwidth depends upon vertical plug-in. Output R is 950 Ω nominal.

**External Single-Sweep Reset** — Ground closure, rear-panel input to reset sweep.

**Camera Power** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

**Probe Power** — Two rear-panel connectors provide correct operating voltages for two active probes. Probe power is deleted on Option 01 of 7704A.

**CALIBRATOR**

**Voltage Output** — Rectangular waveshape, positive-going from ground (40 V and 4 mV available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Rep rate is 1 kHz within 0.25% (+15°C to +35°C); within 0.5% (0°C to +50°C).

**Current Output** — 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks.

**POWER REQUIREMENTS**

**Line Voltage Ranges** — 90 V to 132 V ac and 180 V to 264 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 180 W, 2.5 A at 115 V line, 60 Hz.

## CHARACTERISTICS (R7704)

The following characteristics are unique to the R7704, other characteristics are common with the 7704A.

**HORIZONTAL SYSTEM**

**X-Y Mode** — Phase shift is within 2° from dc to 35 kHz between vertical and horizontal channels. Frequency response at 10% down is dc to at least 3 MHz.

**Option 02, X-Y Horizontal Compensation** — Provides phase shift compensation to <2° from dc to 2 MHz.

**CRT**

**External Z-Axis Input** — Minimum pulse width to blank trace is 30 ns at 2 V; 2 V p-p for full intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace; input R is 500 Ω within 10%. Maximum input voltage is 15 V (dc + peak ac) and p-p ac.

**OUTPUTS/INPUTS**

**Probe Power** — R7704 connectors are located on both the front and rear panels.

**POWER REQUIREMENTS**

**Line Frequency** — 48 Hz to 66 Hz.

**Option 05, Line Frequency Change (50 Hz to 400 Hz)** — Converts the R7704 to 50 Hz to 400 Hz operation (not required for 7704A).

**Maximum Power Consumption** — 225 W, 2.8 A at 115 V line, 60 Hz.

**INCLUDED ACCESSORIES (7704A)**

20 in two-pin-to-BNC cable (175-1178-00); instruction manual.

**INCLUDED ACCESSORIES (R7704)**

42 in BNC 50 Ω cable (012-0057-01); rackmounting hardware; instruction manual.

**Weights and Dimensions** — See page 230.

**For Recommended Cameras** — see page 421.

**For Recommended Plug-ins** — See pages 230-231.

**For Recommended Probes** — See pages 230 and 440.

## ORDERING INFORMATION

**(PLUG-INS NOT INCLUDED)**

**7704A** Oscilloscope ..... **$4,660**

**R7704** Oscilloscope ..... **$7,895**

**OPTIONS (7704A)**

**Option 01** — Without CRT Readout and Probe Power . **−$350**

**Option 03** — EMC Capability ..... **+$375**

**Option 09** — Bandwidth Change (250 MHz) ..... **+$500**

**Option 13** — Maximum Brightness 4 cm x 5 cm CRT Display with BE (P11) Phosphor ..... **+$600**

**Option 78** — BE (P11) Phosphor ..... **+$100**

**OPTIONS (R7704)**

**Option 01** — Without CRT Readout ..... **−$350**

**Option 02** — X-Y Horizontal Comp ..... **+$250**

**Option 03** — EMC Capability ..... **+$375**

**Option 05** — Line Frequency Change (50 Hz to 400 Hz) (not required for 7704A) ..... **+$300**

**Option 78** — BE (P11) Phosphor ..... **+$100**

**CONVERSION KITS (7704A)**

**CRT Readout and Probe Power** — Order 040-0613-05 . **$740**

**EMC Capability** — Order 040-0612-00 ..... **$375**

**Sig Out/In** — Order 040-0619-03 ..... **$200**

**CONVERSION KITS (R7704)**

**CRT Readout** — Order 040-0533-01 ..... **$650**

**X-Y Horizontal Comp** — Order 040-0529-00 ..... **$390**

**EMC Capability** — Order 040-0562-00 ..... **$375**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS (7704A ONLY)**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

**Tektronix offers service training classes on the 7704A General Purpose Oscilloscope. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.**

## 7603/R7603

**Dc to 100 MHz Bandwidth**

**3.5 ns Risetime**

**6.5 Inch CRT**

**CRT Readout**

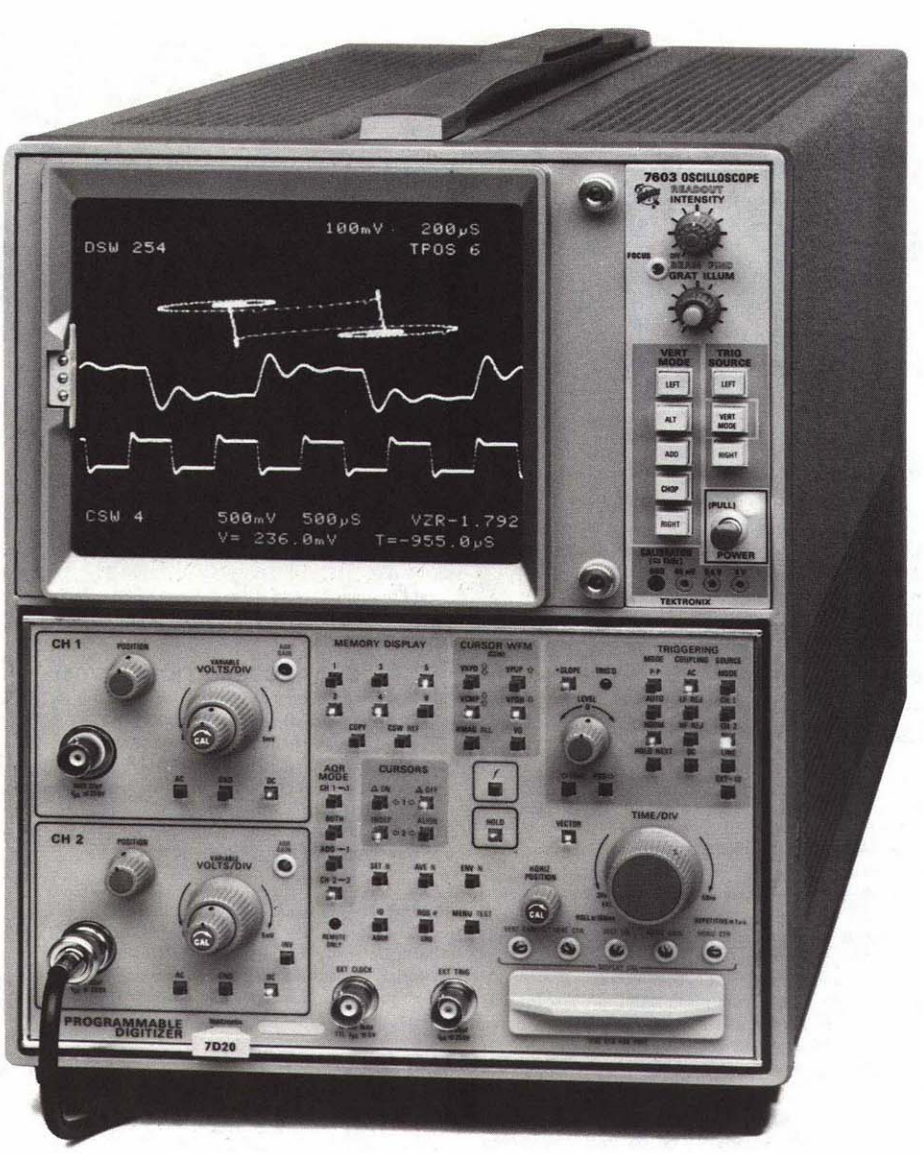
**5.25 Inch Rackmount**

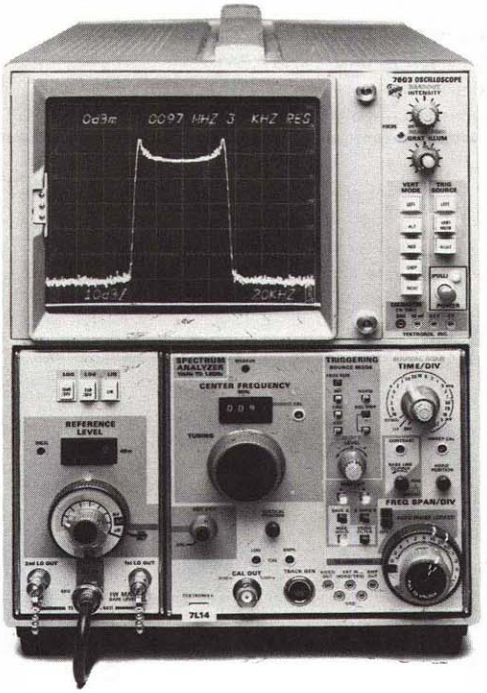
## TYPICAL APPLICATIONS

- **Digital Design and Testing**
- **Communications**
- **Spectrum Analysis**

The Tektronix 7603 and R7603 Oscilloscopes represent the best price/performance ratio available in the 100 MHz plug-in oscilloscope market today.

The CRT is large—8 x 10 div (1.22 cm/div)—and features an internal graticule with variable illumination and 15 kV accelerating potential. An optional maximum brightness CRT with a smaller 8 cm x 10 cm display and 18 kV potential gives you greater visual brightness and higher photographic writing speed. See page 221 for writing rate specifications.




*The 7L4N converts the 7603 Oscilloscope to a 1.8 GHz Spectrum Analyzer.*

## CHARACTERISICS

### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins. Bandwidth determined by mainframe and plug-in unit. See Vertical System Specifications Chart on page 231.

**Modes of Operation** — Left, Alt, Add, Chop, Right.

**Chopped Mode** — Rep rate is ≈1 MHz.

**Delay Line** — Permits viewing leading edge of displayed waveform.

### HORIZONTAL SYSTEM

**Channels** — One right-hand plug-in compartment; compatible with all 7000 Series plug-ins.

**Fastest Calibrated Sweep Rate** — 5 ns/div.

**X-Y Mode** — The phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz. Bandwidth is dc to at least 2 MHz.

### CRT AND DISPLAY FEATURES

**Standard** — Internal 8 x 10 div (1.22 cm/div) graticule with variable illumination. Accelerating potential is 15 kV with GH (P31) phosphor standard.

**Option 01** — No CRT readout. (CRT readout may be added later with Conversion Kit 040-0654-02.)

**Option 06, Spectrum Analyzer Graticule.**

**Option 13, Maximum Brightness CRT with Reduced Area** — Internal 8 cm x 10 cm graticule with BE (P11) phosphor. Has accelerating potential of 18 kV.

**Optional Phosphors (Specify)** — GM (P7), BE (P11), or GM (P7)/SA, (phosphor/Spectrum Analyzer graticule combination.)

*The R7603 requires only 5.25 inches of rack height in a standard 19 inch rack. It is fan cooled and comes complete with slide-out chassis tracks.*

**External Z-Axis Input** — 2 V p-p for full intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Maximum input voltage is 10 V (dc + peak ac) and p-p ac.

**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been adjusted.

**Beam Finder** — Limits display within graticule area.

### REAR PANEL OUTPUTS/INPUTS

**+Sawtooth Out** — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output R is 950 Ω. Output voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω.

**+Gate Out** — Positive gate of the same duration and coincident with sweep. Output R is 950 Ω. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Risetime is 20 ns or less into 50 Ω. Source is selectable from Main, Delay, or Auxiliary Gate.

**Vert Sig Out** — Selected by Trigger Source switch. Output voltage is 0.5 V/div into 1 MΩ, 25 mV/div into 50 Ω. Output R is 950 Ω. Bandwidth depends upon vertical plug-in. See Vertical System Specifications Chart on page 231.

**External Single-Sweep Reset** — Ground closure, rear panel BNC provides input to reset sweep.

**Single-Sweep Ready Output** — Rear panel BNC provides 5 V out to indicate single-sweep ready condition.

### CAMERA POWER OUTPUT

Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

### CALIBRATOR

**Voltage Output** — Rectangular waveshape, positive-going from ground (dc voltage available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Rep rate is ≈1 kHz.

**Current Output** — 40 mA rectangular waveshape (dc current available when selected by internal jumper) with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks.

### POWER REQUIREMENTS

**Line Voltage Ranges** — 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quick-change jumpers.

**Line Frequency** — 50 Hz to 60 Hz (R7603 and 7603).

**Option 05, Line Frequency Change (50 Hz to 400 Hz)** — Converts the R7603 and 7603 to 50 Hz to 400 Hz operation.

**Maximum Power Consumption** — 180 W, 2.0 A at 115 V line, 60 Hz. Cooling is provided by a fan.

### INCLUDED ACCESSORIES

For 7603 and R7603: a 20 in two-pin-to-BNC cable (175-1178-00); blue CRT filter (337-1700-01); clear CRT filter (337-1700-04); instruction manual. The R7603 includes rack-mounting hardware.

**Dimensions and Weights** — See page 230.

**For Recommended Cameras** — See page 421.

**For Recommended Plug-ins** — See pages 230-231.

**For Recommended Probes** — See pages 230 and 440.

## ORDERING INFORMATION

**(PLUG-INS NOT INCLUDED)**

**7603** Oscilloscope ..... **$2,955**

**R7603** Oscilloscope ..... **$3,385**

### OPTIONS (7603/R7603)

**Option 01** — Without CRT Readout ..... **−$350**

**Option 03** — EMC Capability ..... **+$375**

**Option 05** — Line Frequency Change (50 Hz to 400 Hz) ..... **+$300**

**Option 06** — With Internal Spectrum Analyzer Graticule ..... **+$50**

**Option 13** — Maximum Brightness 8 cm x 10 cm CRT Display with BE (P11) Phosphor ..... **+$600**

### OPTION (7603)

**Option 08** — Protective Panel Cover ..... **+$100**

### OPTION (R7603)

**Option 20** — IEEE Standard 488 Interface for the 7D20 only. (Deletes rear panel + sawtooth out, + gate out, and vert sig out.) ..... **+$250**

### CONVERSION KITS (7603)

**CRT Readout** — Order 040-0654-02 ..... **$650**

**EMC Capability** — Order 040-1000-00 ..... **$375**

**Power Supply** — To Light Plug-in Pushbuttons. Order 040-0686-01 ..... **$70**

**X-Y Horizontal Comp** — Order 040-0718-00 ..... **$390**

### CONVERSION KITS (R7603)

**CRT Readout** — Order 040-0674-02 ..... **+$650**

**EMC Capability** — Order 040-0955-00 ..... **+$375**

**Power Supply** — To Light Plug-in Pushbuttons. Order 040-0686-01 ..... **+$70**

**X-Y Horizontal Comp** — Order 040-0718-00 ..... **$390**

### PHOSPHOR OPTIONS (7603/R7603)

**Option 76** — GM (P7) Phosphor ..... **+$100**

**Option 77** — GM (P7) Phosphor with Internal Spectrum Analyzer Graticule ..... **+$100**

**Option 78** — BE (P11) Phosphor ..... **+$100**

### INTERNATIONAL POWER CORD AND PLUG OPTIONS (7603 and R7603)

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

**Option A5** — Switzerland 220 V/10 A, 50 Hz

### OPTIONAL ACCESSORIES (R7603)

A field installable kit adds Option 20 to the standard R7603. Intended for use with a previously purchased R7603, this kit provides parts to connect the 7D20's IEEE Standard 488 Interface to the R7603 mainframe.

Order 040-1093-00 ..... **$380**

Five other field installable kits are available, one for each of the international power cord and plug options, A1-A5. Contact your local Tektronix Field Office for information.

**A1** — Universal Euro. Order 040-1094-00 ..... **$345**

**A2** — UK. Order 040-1095-00 ..... **$300**

**A3** — Australian. Order 040-1096-00 ..... **$300**

**A4** — North American. Order 040-1097-00 ..... **$300**

**A5** — Switzerland. Order 040-1098-00 ..... **$300**

## 7844/R7844

**400 MHz Bandwidth**

**900 ps Risetime**

**True Dual Beam (Dual-Gun)**

**Full Vertical Crossover Switching**

**8 cm x 10 cm Display**

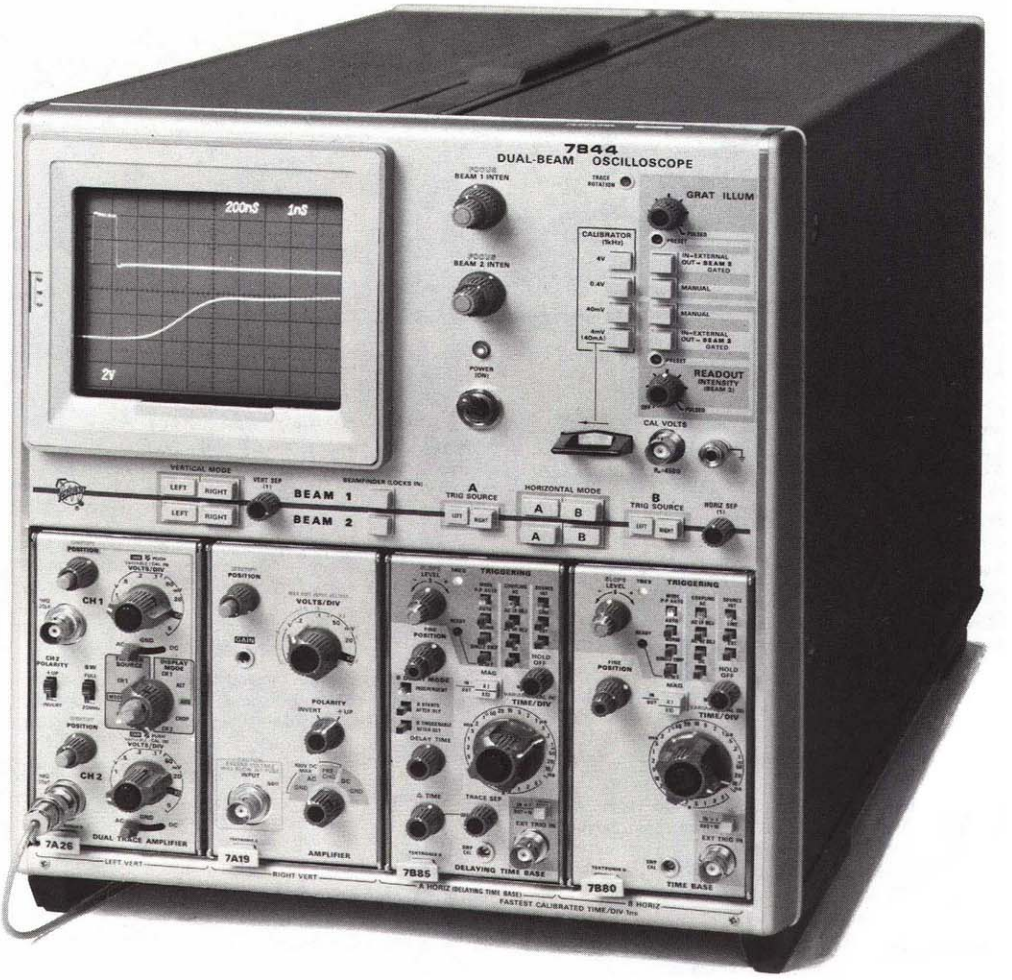
**CRT Readout**

**1 ns/div Maximum Calibrated Sweep**

## TYPICAL APPLICATIONS

* **Radar/Lidar**
* **Destructive Testing**
* **SCR Switching**

The 7844 and 7 inch rackmount R7844 are wide bandwidth, dual-beam oscilloscopes designed primarily for fast, single-shot events. Unique features such as pulsed graticule and pulsed CRT readout allow you to photograph vertical and horizontal scale factors, test date, test number, and other pertinent data before or after an event. Vertical signal crossover switching permits you to view a single event from a single probe at two sweep speeds. See page 221 for photographic writing speed specifications.




## CHARACTERISTICS

### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins. Bandwidth determined by mainframe and plug-in unit. See page 231.

**Display Logic**

| | Beam 1 | Beam 2 |
|---|---|---|
| Vertical Compartment Controlling Beam | Left | Left |
| | Left | Right |
| | Right | Left |
| | Right | Right |

**Vertical Crossover** — Permits viewing the same signal on two time bases.

**Vertical Trace Separation** — Beam 1 can be positioned ±4 cm with respect to Beam 2.

**Delay Line** — Permits viewing leading edge of displayed waveform when using 7B80 and 7B90 Series time bases; not compatible with 7B50 Series.

### HORIZONTAL SYSTEM

**Channels** — Two right-hand plug-in compartments; compatible with time bases of the 7B80 and 7B90 Series. 7000 Series vertical amplifiers and specialized plug-ins may also be used. 7B53AN11 requires modification for use in the 7844.

**Fastest Calibrated Sweep Rate** — 1 ns/div.

**X-Y Mode** — Phase shift is within 2° from dc to 50 kHz.

**Bandwidth** — Dc to at least 1 MHz.

**Horizontal Separation** — Beam 1 can be positioned at least 0.25 cm to the right and at least 0.25 cm to the left of Beam 2 with a total 2 cm range.

**Display Logic**

| Beam 1 | Beam 2 |
|---|---|
| A Horizontal | A Horizontal |
| A Horizontal | B Horizontal |
| B Horizontal | A Horizontal |
| B Horizontal | B Horizontal |

### CRT AND DISPLAY FEATURES

**CRT** — Dual beam, full overlap. 8 cm x 10 cm graticule with variable illumination. CRT readout intensity is adjustable with front-panel control. Accelerating potential is 24 kV with GH (P31) phosphor standard.

**Option 78** — BE (P11) phosphor.

**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

**Beam Finder (Beam 1 and Beam 2, Independent Controls)** — Limits display within graticule area and intensifies beam.

**External Z-Axis Input (Beam 1 and Beam 2)** — 2 V p-p for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac), p-p ac and dc coupled.

**Typical Photographic Writing Speed (Using Polaroid Type 612 20,000 ASA Film without Film Fogging)** — In typical camera applications, GH (P31) phosphor has about one-half the writing speed of BE (P11) phosphor. Writing speed can be increased by using controlled film fogging with a writing speed enhancer.

The photographic writing speed enhancer, Option 22, provides a preset automatic method of film fogging for the 7844. Option 22 is recommended for writing speed enhancement when a camera with a writing speed enhancer is not available.

**Pulsed Readout and Graticule Illumination** — Provides a means of pulsing the graticule lights and CRT readout at a preset level, coincident with a single-shot event in one exposure. The graticule lights and CRT readout can be pulsed by the event, an external ground closure, or front-panel pushbutton.

### CALIBRATOR

**Calibrator** — Rectangular waveform positive-going from ground, 1 kHz (±0.25%).

**Voltage Ranges** — 4 mV, 40 mV, 0.4 V, 4 V (±1%) into an open circuit; 0.4 mV, 4 mV, 40 mV, 0.4 V (±1%) into 50 Ω.

**Current Output** — 40 mA (±1%) rectangular waveshape, front panel current loop 7844, optional current loop adaptor (012-0341-00) required for R7844.

### OUTPUTS/INPUTS

**A and B + Sawtooth** — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.

**A and B + Gate** — Positive-going rectangular waveform derived from Main or Delayed Gate. Output voltage 0.5 V (±10%) into 50 Ω. 10 V (±10%) into 1 MΩ. Risetime is 5 ns or less into 50 Ω. Output R is ≈950 Ω.

**Single-Sweep Ready Output** — +5 V, rear panel BNC output, for single-sweep ready indication.

**External Single-Sweep Reset** — Ground closure, rear panel BNC, provides input to reset sweeps.

**Camera Power** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series cameras.

**Probe Power** — Two connectors provide correct operating voltages for two active probes.

### POWER REQUIREMENTS

**Line Voltage Ranges** — Selectable 115 V nominal (90 V to 132 V), 230 V nominal (180 V to 264 V).

**Line Frequency** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 235 W, 2.9 A at 60 Hz 115 V line.

### INCLUDED ACCESSORIES (R7844)

Rackmount hardware kit and slide guide (351-0314-01); power cord; instruction manual.

**Dimensions and Weights** — See page 230.

**For Recommended Cameras** — See page 421.

**For Recommended Plug-ins** — See pages 230-231.

**For Recommended Probes** — See pages 230 and 440.

## ORDERING INFORMATION

**(PLUG-INS NOT INCLUDED)**

**7844** Oscillosope ..... **$14,265**

**R7844** Oscillosope ..... **$14,705**

**Option 03** — EMC Capability ..... **+$375**

**Option 22** — Writing Speed Enhancer ..... **+$400**

**Option 78** — BE (P11) Phosphor ..... **+$100**

### INTERNATIONAL POWER CORDS AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

**Option A5** — Switzerland 220 V/10 A, 50 Hz

# 7000 SERIES CRT STORAGE MAINFRAMES

Storage mainframes in the 7000 Series offer a full selection of stored writing speeds: from ≈0.03 cm/μs for mechanical, spectrum analysis, or TDR applications, to 2500 cm/μs for capturing fast single events such as high speed digital logic. A selection of storage modes offers the following features:

**Bistable ..... Long View Time**

**Variable Persistence ..... High Contrast Displays**

**FAST Bistable ..... Captures Fast Single or Multiple Events**

**FAST Variable Persistence ..... Provides Maximum Stored Writing Rate**

## CONTENTS


Nonstorage Mainframes ..... 233

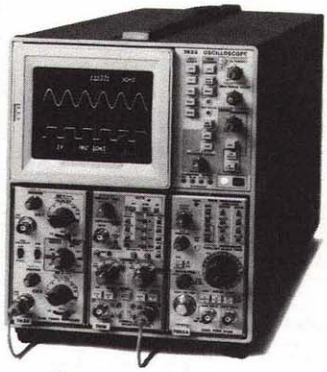
CRT Storage Mainframes ..... 243

Plug-Ins ..... 250

High Performance Digitizing Mainframes ..... 329

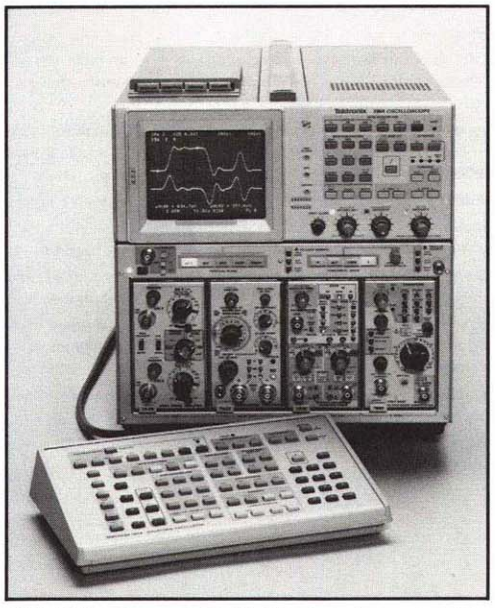
7613
Variable
Persistence

7623A
FAST
Multimode

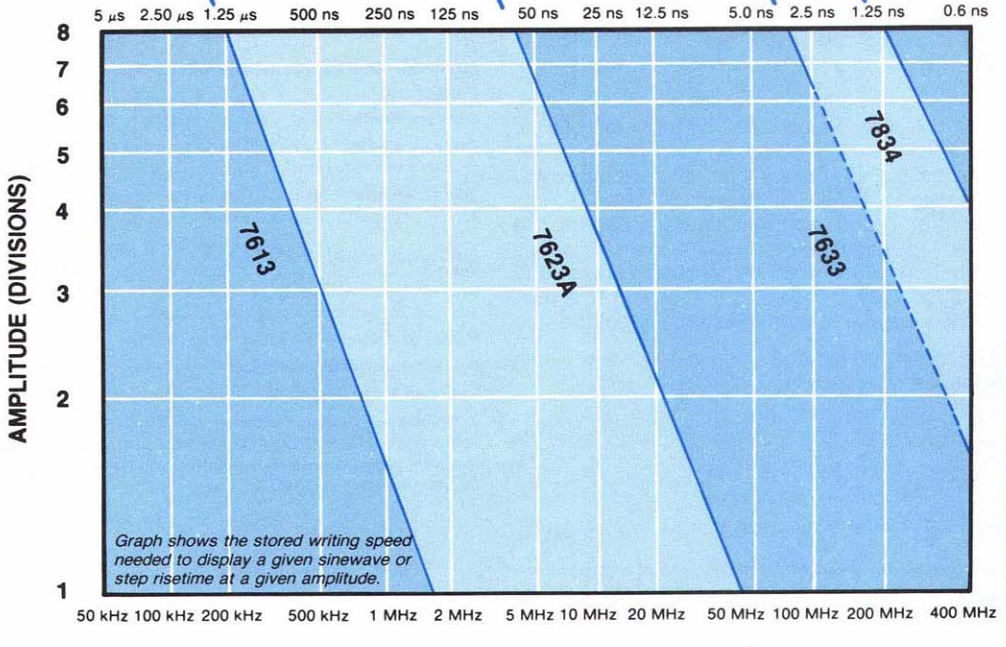


7633
FAST
Multimode

7834
FAST
Multimode



*7854 Digital Storage (400 MHz Waveform Processing). See page 336.*



# 7834

**2500 cm/μs Stored Writing Speed**

**Stores Single-Shot Risetimes as Fast as 1.4 ns**

**Dc to 400 MHz Bandwidth**

**Multimode Storage**

**Long View Time**

## TYPICAL APPLICATIONS

- **Laser Fusion**
- **Digital Design**
- **Radar/Lidar**

The 7834 Storage Oscilloscope has a stored writing speed of 2500 cm/μs, enabling storage of single-shot risetimes to 1.4 ns, 3.6 cm high, at eight-divisions amplitude, reduced-scan mode. The 7834's mainframe bandwidth is 400 MHz. The system bandwidth may vary from 75 MHz to 400 MHz depending on the plug-in selected.*[1]

This instrument has four storage modes: Bistable, Variable Persistence, Fast Bistable and Fast Variable Persistence.

Bistable provides stored displays with long (30 minute) view time.

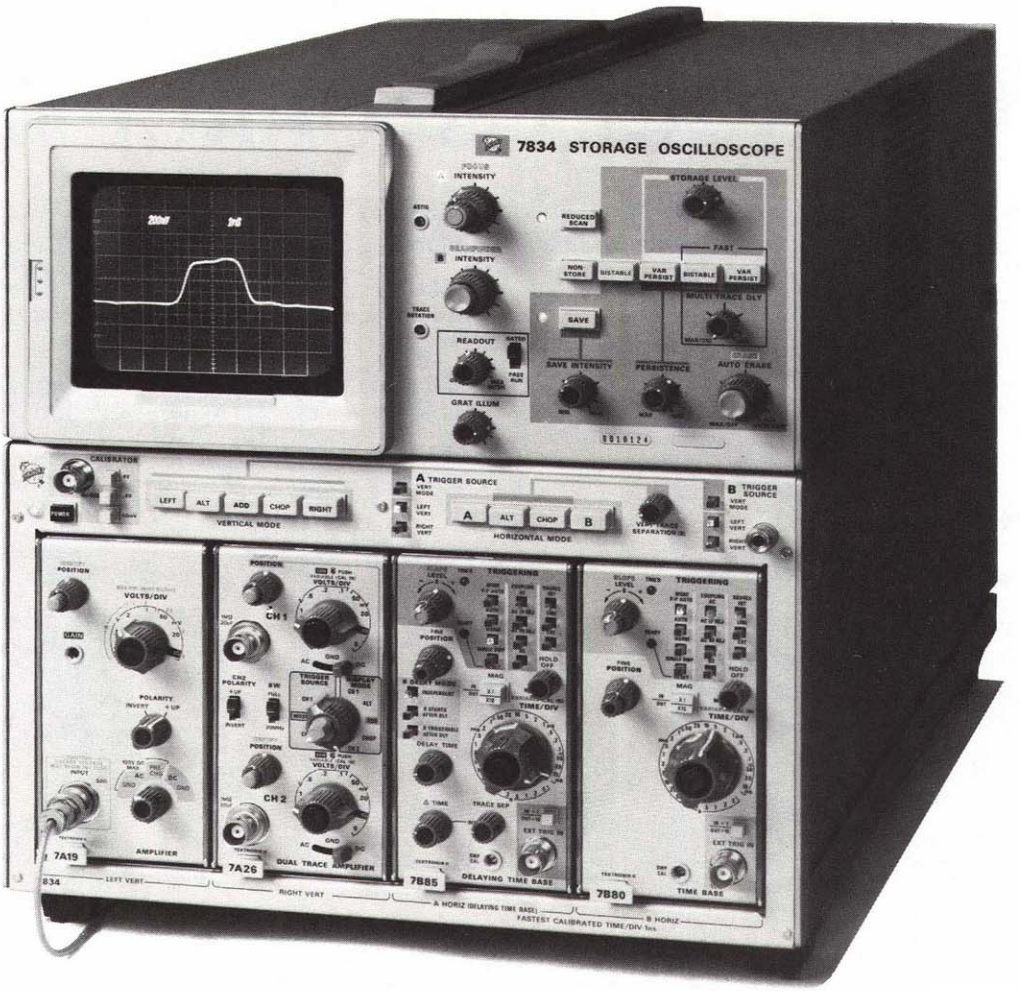
Variable Persistence gives high contrast displays of both single-shot and repetitive phenomena. When viewing changing waveshapes, variable persistence provides continuous bright displays of new information as old information fades from the CRT.

Fast Bistable increases bistable writing rates to 350 cm/μs (reduced scan).

Fast Variable Persistence provides the maximum stored writing rate of 2500 cm/μs (reduced scan). View time is at least 30 seconds.

The four-compartment flexibility means that more than one measurement can be performed at the same time without switching plug-ins. The 7834 also offers auto-erase for automatic display updating...a save control for 30 times longer viewing...gated readout which prevents the blooming that tends to occur between sweeps with nongated readout...and an adjustable multitrace delay for varying the viewing time prior to the next sweep in the Fast transfer mode.

The multimode storage unit is designed for single shot, low-rep-rate or fast pulse analysis.




## CHARACTERISTICS

### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins.

**Modes of Operation** — Left, Alt, Add, Chop, Right.

**Mainframe Bandwidth** — 400 MHz with 7A29 Amplifier plug-in.

**Mainframe Step Response** — 900 ps or less with 7A29 Amplifier plug-in.

**Chopped Mode** — Rep rate is ≈1 MHz.

**Delay Line** — Permits viewing leading edge of displayed waveform (not recommended for use with 7B50 Series time bases).

**Trace Separation Range** — In dual-sweep modes, B trace can be positioned four divisions above or below the A trace.

### HORIZONTAL SYSTEM

**Input** — Two right-hand plug-in compartments; compatible with all 7000 Series plug-ins. 7000 Series vertical amplifiers and specialized plug-ins may also be used.

**Modes of Operation** — A, Alt, Chop, B.

**Fastest Calibrated Sweep Rate** — 1 ns/div.

**Chopped Mode** — Rep rate is ≈200 kHz.

**X-Y Mode** — Phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz without phase correction (dc to 1 MHz with phase correction, B horizontal only, Option 02). Bandwidth is dc to at least 1 MHz.

### CRT AND DISPLAY FEATURES

**Graticule** — Internal variable illuminated graticule. 8 x 10 div (0.9 cm/div) gratule in full scan and 8 x 10 div (0.45 cm/div) in reduced scan.

**Option 01** — Deletes CRT readout and probe power.

**Accelerating Potential** — ≈10 kV full scan mode, and 12 kV in reduced scan mode.

**Phosphor** — GH (P31) is standard.

**CRT Display Modes** — Nonstore, Bistable, Variable Persistence, Fast Bistable and Fast Variable Persistence (full and reduced scan).

**Persistence** — (Variable Persistence mode only) controls rate of continuous erasure of the variable persistence and fast variable persistence stored displays.

**Auto Erase** — Continuously variable from <1 s to >10 s.

**Multitrace Delay** — Adjusts the transfer cycle time in the Fast transfer modes. Continuously variable from <1 s to >4 s.

**Save** — Prevents display from being accidentally erased, and provides up to 30 times longer viewing times in all modes.

**External Z-Axis Input** — 2 V p-p for full intensity range from dc to 1 MHz. Positive signal blanks the trace. Maximum input voltage is 15 V (dc plus peak ac).

**Auto-Focus** — Maintains CRT focus following changes in display intensity after focus control has been initially set.

**Beam Finder** — Limits display within graticule.

*[1] High gain differential amplifiers offer very high gain at lower bandwidths. Consult the system specifications chart on Page 231 for specific plug-ins.*

**STORAGE WRITING SPEED**

**FULL SCAN (Center 6 x 8 div at 0.9 cm/div)**

| Display Mode | Fast Variable Persistence | Fast Bistable | Variable Persistence | Bistable |
|---|---|---|---|---|
| Stored Writing Speed | 270 cm/μs (300 div/μs) | 45 cm/μs (50 div/μs) | 1.8 cm/μs (2 div/μs) | 0.03 cm/μs (.03 div/μs) |
| View Time | 30 s*1 | 30 min*2 | 30 s*1 | 30 min |
| ≈Erase Time | 1.4 s | 1.4 s | 0.9 s | 0.9 s |

**REDUCED SCAN (Center 8 x 10 div at 0.45 cm/div)**

| Display Mode | Fast Variable Persistence | Fast Bistable | Variable Persistence | Bistable |
|---|---|---|---|---|
| Stored Writing Speed | 2500 cm/μs (5,500 div/μs) | 350 cm/μs (776 div/μs) | 5.4 cm/μs (12 div/μs) | 0.09 cm/μs (0.2 div/μs) |
| View Time | 30 s*1 | 30 min*2 | 30 s*1 | 30 min*1 |
| ≈Erase Time | 1.4 s | 1.4 s | 0.9 s | 0.9 s |

*1 *View times are at full stored display intensity. They may be increased more than 30 times by using reduced intensity in the Save display mode.*

*2 *Save intensity at minimum.*

**Fast Variable Persistence Writing Speed**

| Scan Mode | Sweep Speed | Peak-to-Peak Sinewave | Step Response |
|---|---|---|---|
| Reduced Scan 5,500 div/μs (0.45 cm/div) | ≥1 ns/div | 7.1 div 250 MHz | 7.7 div 1.4 ns |
| | | 8 div 221 MHz | 8 div 1.45 ns |
| Full Scan 300 div/μs (0.9 cm/div) | ≥10 ns/div | 3.2 div 30 MHz | 3 div 10 ns |
| | | 6.4 div 15 MHz | 5 div 16.6 ns |

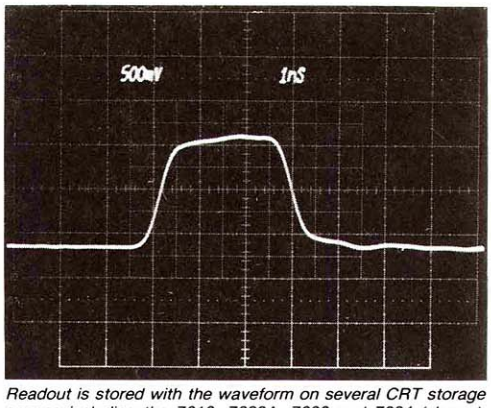
**OUTPUTS/INPUTS**

**+Sawtooth** — Positive going with baseline at 0 V ±1 V into 1 MΩ. Voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω. Output R is ≈950 Ω.

**+Gate** — Positive pulse of the same duration and coincident with sweep. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Output R is ≈950 Ω. Source is selectable from A Gate, B Gate or A Delayed Gate.

**Vertical Signal Out** — Selected by A Trigger Source switch. Output voltage is 0.5 V into 1 MΩ, 25 mV into 50 Ω. Output R is ≈950 Ω. Bandwidth depends upon vertical plug-in.

**Remote Single Sweep Reset, Remote Save and Remote Erase** — Rear panel BNC connector inputs, ground closure activated.




*Readout is stored with the waveform on several CRT storage scopes including the 7613, 7623A, 7633 and 7834 (shown). Multimode storage is available on the 7623A, 7633, and 7834.*

**Remote Fast Transfer Gate** — TTL compatible. Low to high transition enables high speed target to receive information to be stored; high to low transition initiates transfer from high speed target to storage target.

**Camera Power Output** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

**Probe Power** — Two rear-panel connectors provide operating voltages for two active probes such as P6201.

**CALIBRATOR**

**Voltage Output** — Squarewave, positive-going from ground. Ranges are 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%; rep rate is 1 kHz within 0.25%.

**Current Output** — 40 mA available through Calibrator output with optional BNC to current loop adaptor.

**Dimensions and Weight** — See page 230.

**POWER REQUIREMENTS**

**Line Voltage Ranges** — 90 V to 132 V ac and 180 V to 250 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 215 W.

**INCLUDED ACCESSORIES**

Installed gray CRT filter (378-0625-02); green CRT filter (378-0625-08); power cord (161-0066-00); instruction manual.

**For Recommended Cameras** — See page 421.

**For Recommended Plug-ins** — See pages 230-231.

**For Recommended Probes** — See pages 230 and 440.

## ORDERING INFORMATION

**(PLUG-INS NOT INCLUDED)**

**7834** Storage Oscilloscope ..... **$13,055**

**OPTIONS**

**Option 01** — Without CRT Readout and Probe Power ..... **−$350**

**Option 02** — X-Y Mode Phase Correction ..... **+$250**

**Option 03** — EMC Capability ..... **+$375**

**Cradle Mount Adaptor** — For Rackmounting. Order 040-0560-00 ..... **$445**

**CONVERSION KITS**

**CRT Readout** — Order 040-0811-03 ..... **$650**

**X-Y Mode Phase Correction** — Order 040-0942-01 .... **$195**

**EMC Capability** — Order 040-0880-00 ..... **$375**

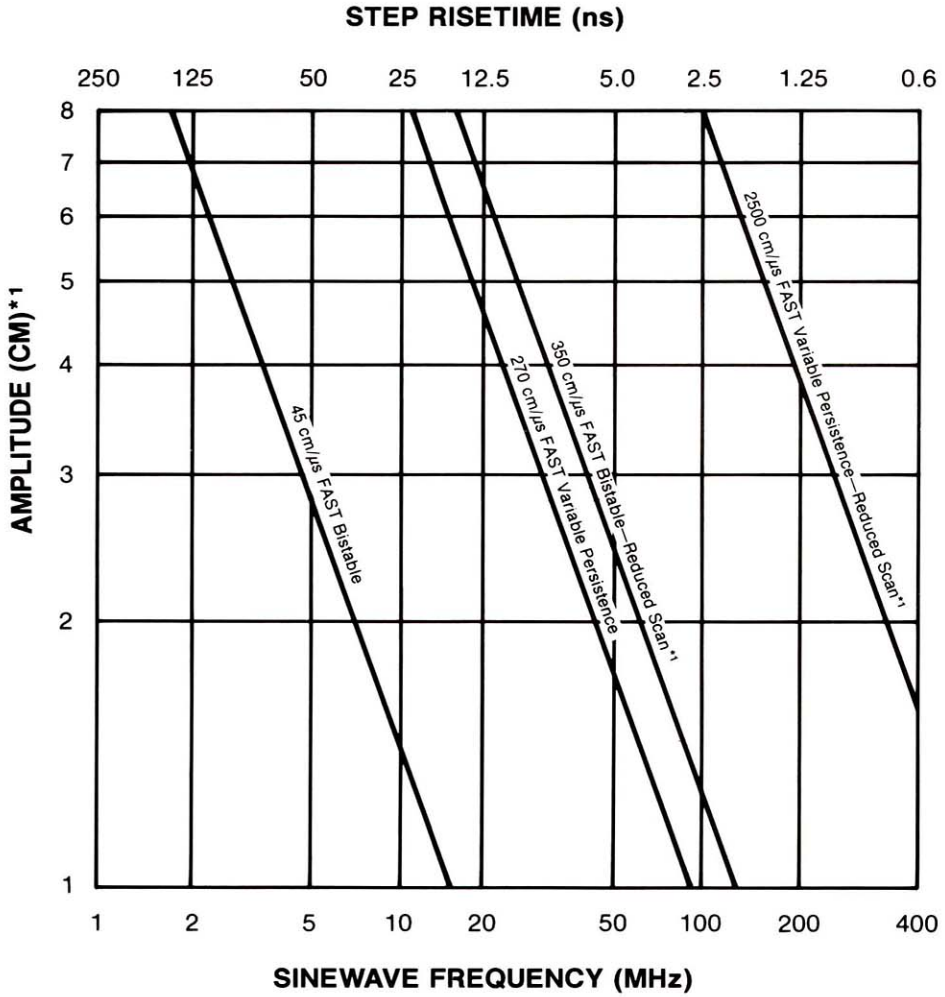
**INTERNATIONAL POWER CORDS AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz




*Graph showing the stored writing speed needed to display a given sinewave or step risetime at a given amplitude.*

*1 *Reduced Scan divisions are 0.45 cm.*

# 7633/R7633 & 7623A/R7623A

**1000 cm/μs Stored Writing Speed (7633/R7633)**

**135 cm/μs Stored Writing Speed (7623A/R7623A)**

**Long View Time**

**Multimode Storage**

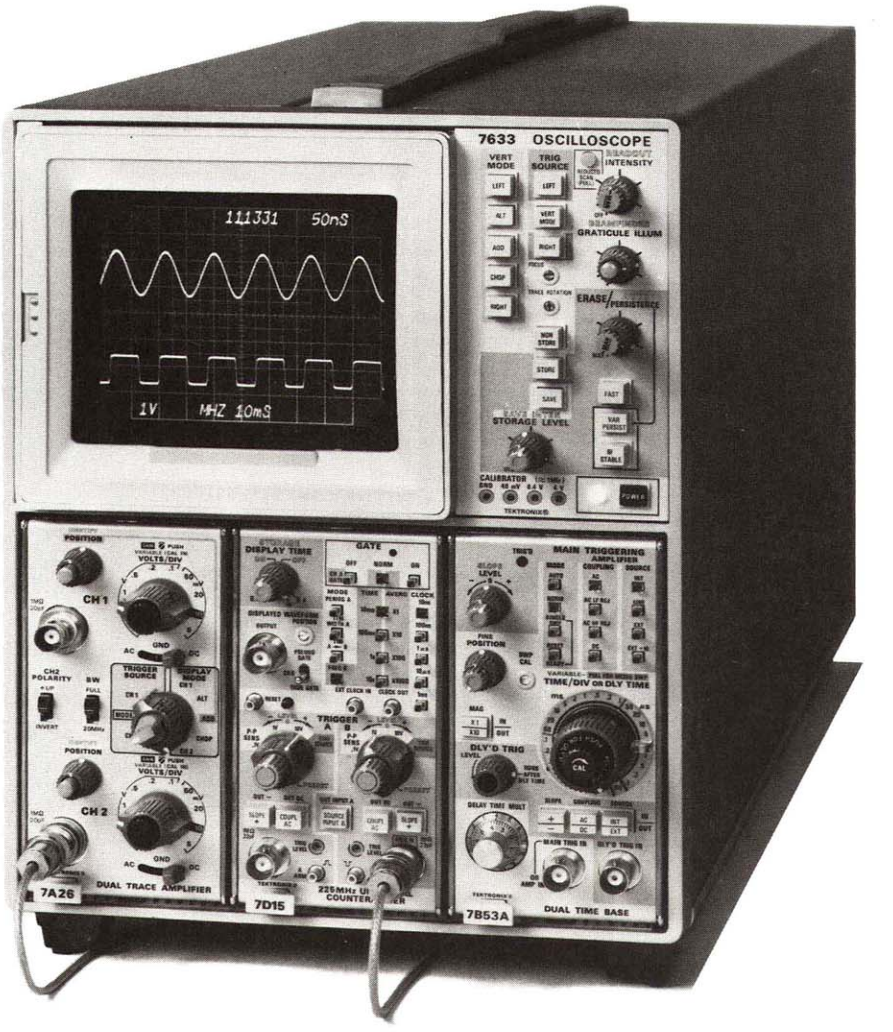
**Dc to 100 MHz Bandwidth**

## TYPICAL APPLICATIONS (7633/R7633)

- **Digital Design**
- **Destructive Test**
- **Communications**

## TYPICAL APPLICATIONS (7623A/R7623A)

- **Ultrasonics**
- **Power Supply Design**
- **Component Testing**




The Tektronix 7633 Storage Oscilloscope provides 2200 div/μs (1000 cm/μs) stored writing speed and 100 MHz bandwidth. The instrument has three display modes—store, nonstore, and save—and four storage modes—bistable, variable persistence, fast bistable, and fast variable persistence. The maximum writing speed of 1000 cm/μs (using the center 8 x 10 reduced scan divisions, 0.45 cm/div) is achieved in reduced scan mode.

This multimode storage instrument allows for retention and viewing for fast-rise, low-repetition-rate, single-shot, or slow-moving waveforms.

The R7633 and R7623A require only 5.25 inches of rack height in a standard 19 inch rack. They are fan cooled and come complete with slide-out chassis tracks.

Characteristics are common to the 7633/R7633 and the 7623A/R7623A unless noted.

The Tektronix 7623A and R7623A Storage Oscilloscope have all the features and performance of the 7633/R7633 except the reduced scan mode.

## CHARACTERISTICS

### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins. Bandwidth determined by mainframe and plug-in unit.

**Modes of Operation** — Left, Alt, Add, Chop, Right.

**Chopped Mode** — Rep rate is ≈1 MHz.

**Delay Line** — Permits viewing leading edge of displayed waveform.

### HORIZONTAL SYSTEM

**Channel** — One right-hand plug-in compartment; compatible with all 7000 Series plug-ins.

**Fastest Calibrated Sweep Rate** — 5 ns/div.

**X-Y Mode** — The phase shift between vertical and horizontal channels is <2° from dc to 35 kHz. Bandwidth is dc to at least 2 MHz.

### CRT AND DISPLAY FEATURES

**CRT** — Internal 8 x 10 div (0.9 cm/div) and 8 x 10 div (0.45 cm/div) graticule with variable illumination.

**Phosphor** — GH (P31) is standard.

**Option 01** — No CRT readout.

**Accelerating Potential** — ≈8.5 kV in normal mode, 10 kV in reduced scan mode.

**Storage Display Modes** — Nonstore, fast variable persistence, fast bistable, variable persistence, bistable. Full or reduced scan may be selected on the 7633 in all display modes. Select normal scan to view the entire CRT; select reduced scan for the fastest writing rate.

**Persistence** — Variable. When set to maximum, provides the longest retention of high contrast stored displays, without the characteristic fading of variable persistence.

**Autoerase** — Variable up to 10 seconds.

**Save** — Prevents erasing and storing additional displays; also extends view time in variable persistence mode.

**External Z-Axis Input** — 2 V p-p for useful intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Maximum input voltage is 10 V (dc + peak ac) and p-p ac.

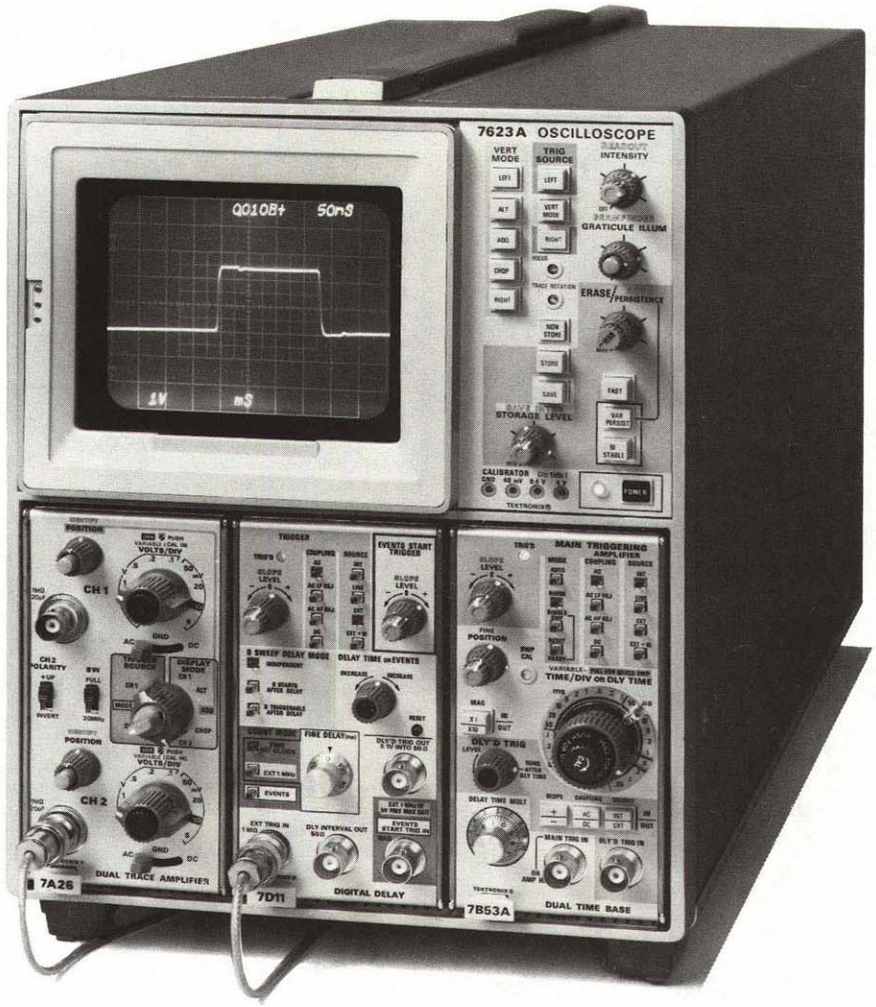
**Autofocus** — Reduces the need for calibrated manual focusing with changes in intensity after focus control has been set.

**Beam Finder** — Limits display within graticule area.

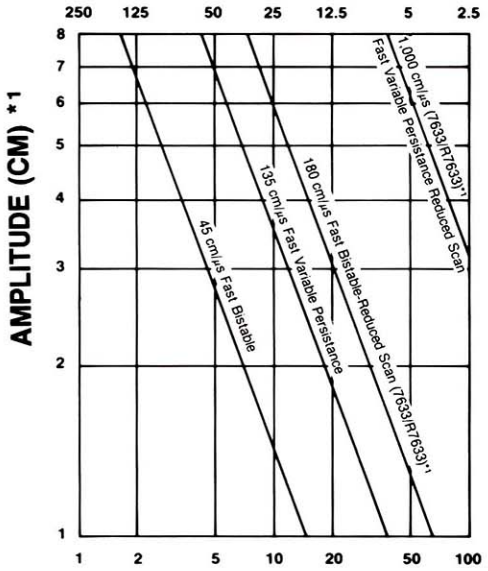
**FAST VARIABLE PERSISTENCE WRITING SPEED**

| Scan Mode | Sweep Speed | Peak-to-Peak Sinewave | Step Response |
|---|---|---|---|
| Reduced Scan*1<br>2200 div/μs<br>(0.45 cm/div) | ⩾5 ns/div | 7.1 div<br>100 MHz<br>8 div<br>89 MHz | 7.7 div<br>3.5 ns<br>8 div<br>3.7 ns |
| Full Scan*2<br>150 div/μs<br>(0.9 cm/div) | ⩾50 ns/div | 3.2 div<br>15 MHz<br>6.4 div<br>7.5 MHz | 3 div<br>20 ns<br>5 div<br>33 ns |

*1 *Applies to 7633/R7633 only.*
*2 *Applies to 7633/R7633 and 7623A/R7623A.*




## STEP RISETIME (ns)




## SINEWAVE FREQUENCY (MHz)

*Graph showing the stored writing speed needed to display a given sinewave or step risetime at a given amplitude.*

** Reduced Scan divisions are 0.45 cm.*

### POWER REQUIREMENTS

**Line Voltage Ranges** — 100 V, 110 V, 120 V, 200 V, 220 V, and 240 V ac ±10%; internally selectable with quick change jumpers.

**Line Frequency** — 50 Hz to 60 Hz.

**Option 05, Line Frequency Change (50 Hz to 400 Hz)** — Converts the 7633, R7633, 7623A and R7623A to 50 Hz to 400 Hz operation.

**Maximum Power Consumption** — 180 W, 2.0 A at 115 V line, 60 Hz. Fan cooling is provided for all models.

### INCLUDED ACCESSORIES

20 in two-pin-to-BNC cable (175-1178-00); green CRT filter (378-0625-08); instruction manuals. The R7633 and R7623A include rackmounting hardware.

**Weights and Dimensions** — See page 230.

**For Recommended Cameras** — See page 421.

**For Recommended Plug-ins** — See pages 230-231.

**For Recommended Probes** — See pages 230 and 440.

### STORAGE WRITING SPEED

**FULL SCAN (7633/R7633 and 7623A/R7623A)**

| Display Mode | Fast Variable Persistence | Fast Bistable | Variable Persistence | Bistable |
|---|---|---|---|---|
| Stored Writing Speed | 135 cm/µs | 45 cm/µs | 0.45 cm/µs | 0.03 cm/µs |
| View Time | 30 s*1 | 30 min minimum | 30 s*1 | 30 min minimum |
| ≈ Erase Time | 1.4 s | 1.4 s | 0.9 s | 0.9 s |

**REDUCED SCAN (7633/R7633 Only)**

| Display Mode | Fast Variable Persistence | Fast Bistable | Variable Persistence | Bistable |
|---|---|---|---|---|
| Store Writing Speed | 1000 cm/µs | 180 cm/µs | 1.35 cm/µs | 0.09 cm/µs |
| View Time | 30 s*1 | 30 min minimum | 30 s*1 | 30 min minimum |
| ≈ Erase Time | 1.4 s | 1.4 s | 0.9 s | 0.9 s |

**1 These times are at full stored display intensity. They may be increased more than 30 times by using reduced intensity in the Save display mode.*

### OUTPUTS/ INPUTS

**+Sawtooth** — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) Into 1 MΩ. Output R is 950 Ω within 2%.

**+Gate** — Positive pulse of the same duration and coincident with sweep. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%,) into 1 MΩ. Risetime is 20 ns or less into 50 Ω, output R is 950 Ω within 2%. Source is selectable from main, delay, or auxiliary gate.

**Vertical Signal Out** — Selected by Trigger Source switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Bandwidth depends on vertical plug-in. Output R is 950 Ω within 2%.

**External Single-Sweep Reset** — Ground closure; rear panel BNC provides input to reset sweep.

**Remote Erase** — Ground closure; rear panel BNC provides input to erase stored trace.

### CAMERA POWER OUTPUT

Three-prong connector to the left of the CRT provides power, ground and remote single-sweep reset access for the C-50 Series cameras.

### CALIBRATOR

**Voltage Output** — Rectangular waveshape, positive-going from ground (dc voltage available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (15°C to 35°C); within 2% (0°C to 50°C). Rep rate is ≈1 kHz.

**Current Output** — 40 mA dc or 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks.

## ORDERING INFORMATION

**(PLUG-INS NOT INCLUDED)**

**7633** Storage Oscilloscope ..... **$8,660**
**R7633** Storage Oscilloscope ..... **$9,105**
**7623A** Storage Oscilloscope ..... **$6,700**
**R7623A** Storage Oscilloscope ..... **$7,145**

### OPTIONS

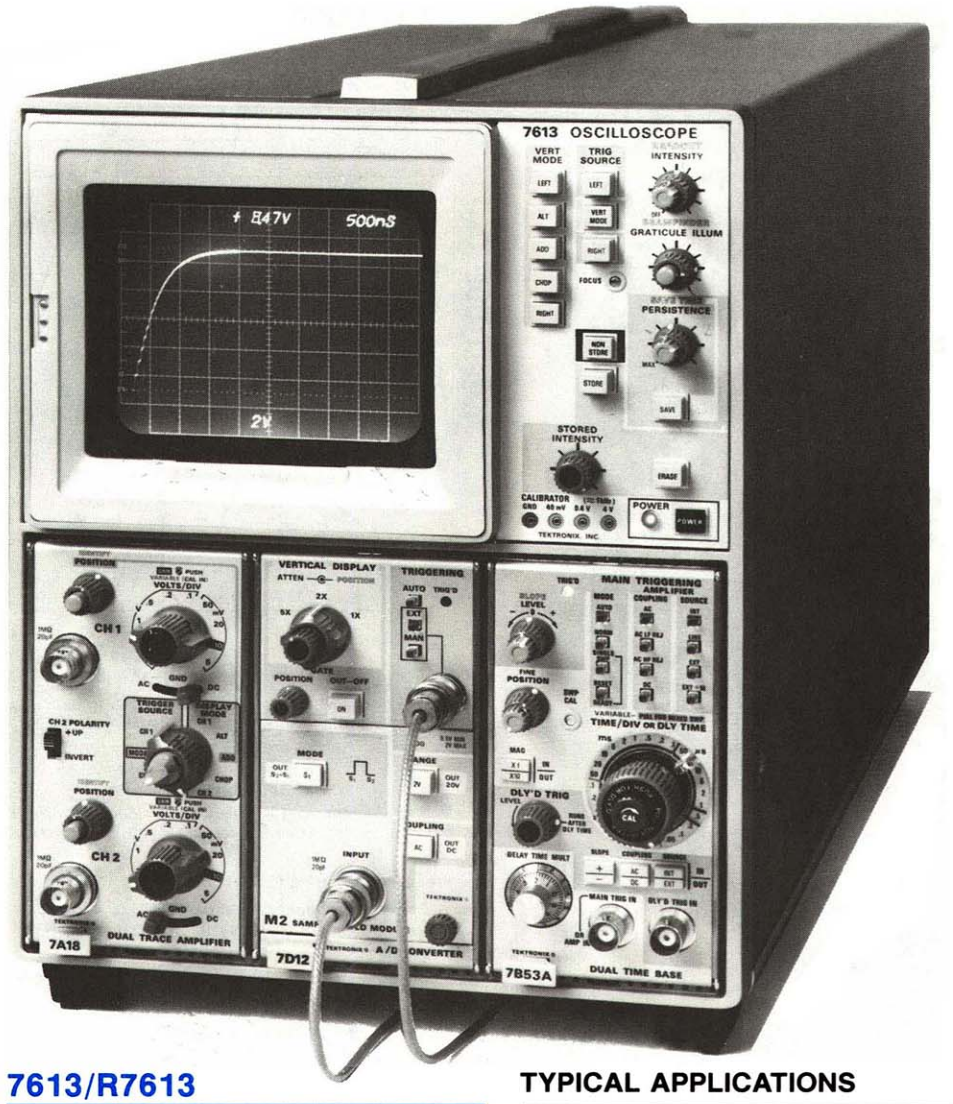
**Option 01** — Without CRT Readout ..... **−$350**
**Option 03** — EMC Capability ..... **+$375**
**Option 05** — Line Frequency Change (50 Hz to 400 Hz) ..... **+$300**

### CONVERSION KITS

**CRT Readout**
Order 040-0748-01 — For Cabinet Models ..... **$650**
Order 040-0759-01 — For Rackmount Models ..... **$650**

**EMC Capability**
Order 040-0663-01 — For Cabinet Models ..... **$375**
Order 040-0678-01 — For Rackmount Models ..... **$375**

**Power Supply** — To Light Plug-in Pushbuttons. Order 040-0686-01 ..... **$70**




## 7613/R7613

**4.5 cm/μs Stored Writing Speed**

**Long View Time**

**Variable Persistence Storage**

**Dc to 100 MHz Bandwidth**

**5.25 Inch Rackmount Height**

## TYPICAL APPLICATIONS

- **Audio**
- **Mechanical Transducers**
- **Spectrum Analysis**

The Tektronix 7613 Storage Oscilloscope offers variable persistence operation with a stored writing speed of 5 div/μs or nonstorage operation. Stored traces may be viewed up to 60 minutes on a display area of 8 x 10 div (0.9 cm/div).

## CHARACTERISTICS

### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins. Bandwidth determined by mainframe and plug-in unit. See Vertical System Specifications Chart on page **xxx**.

**Modes of Operation** — Left, Alt, Add, Chop, Right.

**Chopped Mode** — Rep rate is ≈1 MHz.

**Delay Line** — Permits viewing leading edge of displayed waveform.

### HORIZONTAL SYSTEM

**Channel** — One right-hand plug-in compartment; compatible with all 7000 Series plug-ins.

**Fastest Calibrated Sweep Rate** — 5 ns/div.

**X-Y Mode** — The phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz. Bandwidth is dc to at least 2 MHz.

### CRT AND DISPLAY FEATURES

**Variable Persistence Storage CRT** — Internal 8 x 10 div (0.9 cm/div) graticule with variable illumination.

**Phosphor** — GH (P31) is standard.

**Option 01** — No CRT readout

**Accelerating Potential** — 8.5 kV.

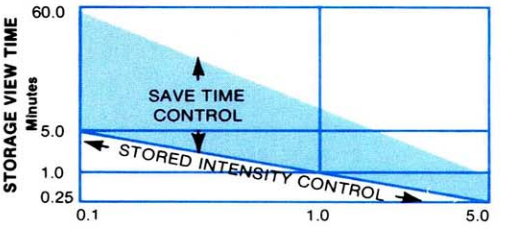
**Nonstore Mode** — For displaying waveforms in the conventional (nonstorage) mode.

**Store Mode** — For displaying waveforms using the variable persistence storage feature.

**Maximum Stored Writing Speed** — >4.5 cm/μs.

**View Time** — The view time is the amount of time the stored signal can be viewed before it fades away.

At the maximum writing speed the view time is 15 s or 0.25 minutes with the stored intensity control fully cw. Adjusting the stored intensity ccw will reduce the stored writing speed, but view time can be increased up to 5 minutes (see the chart below).




**STORED WRITING SPEED (div/μs at MAXIMUM PERSISTENCE)**

**Erase Time** — 0.5 s or less.

**Persistence** — The persistence control also varies the view time. The persistence can be adjusted from almost instantaneous disappearance (fade away), to off, which provides the view time selected by the stored intensity control.

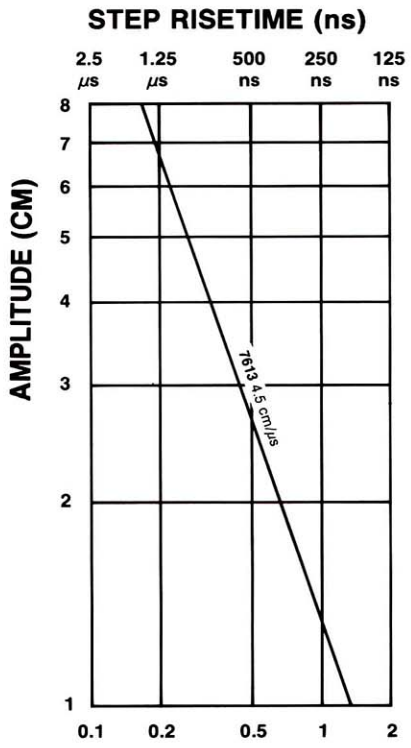
**Save** — Prevents erasure of the stored display and activates the save time control.

**Save Time Control** — Allows an extension of the view time (see Storage View Time Chart above).

**External Z-Axis Input** — 2 V p-p for full intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Maximum input voltage is 10 V (dc + peak ac) and p-p ac.

**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

**Beam Finder** — Limits display within graticule area.




*Graph showing the stored writing speed needed for a given sinewave or step risetime at a given amplitude.*

### OUTPUTS/INPUTS

**+Sawtooth** — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is 950 Ω within 2%.

**+Gate** — Positive pulse of the same duration and coincident with sweep. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Risetime is 20 ns or less into 50 Ω; output R is 950 Ω within 2%. Source is selectable from main, delay, or auxiliary gate.

**Sig Out** — Selected by Trigger Source switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Bandwidth depends upon vertical plug-in. Output R is 950 Ω within 2%.

**External Single-Sweep Reset** — Ground closure; rear panel BNC provides input to reset sweep.

**Remote Erase** — Ground closure; rear panel BNC provides input to erase stored trace.

### CAMERA POWER OUTPUT

Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

### CALIBRATOR

**Voltage Output** — Rectangular waveshape, positive-going from ground. (Dc voltage available when selected by internal jumper.) Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (15°C to 35°C); within 2% (0°C to 50°C). Rep rate is ≈1 kHz.

**Current Output** — 40 mA dc or 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks.

### POWER REQUIREMENTS

**Line Voltage Ranges** — 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quick change jumpers.

**Line Frequency** — 50 Hz to 60 Hz.

**Option 05, Line Frequency Change (50 Hz to 400 Hz)** — Converts the 7613 and R7613 to 50 Hz to 400 Hz operation.

**Maximum Power Consumption** — 180 W, 2.0 A at 115 V line, 60 Hz. Fan cooling is provided for both models.

### INCLUDED ACCESSORIES (FOR 7613 AND R7613)

20 inch two-pin-to-BNC cable (175-1178-00); gray CRT filter (378-0625-02); instruction manual. The R7613 includes rack-mounting hardware.

**Dimensions and Weight** — See page 230.

**For Recommended Cameras** — See page 421.

**For Recommended Plug-ins** — See pages 230-231.

**For Recommended Probes** — See pages 230 and 440.

## ORDERING INFORMATION

**(PLUG-INS NOT INCLUDED)**

**7613** Storage Oscilloscope ..... **$5,660**

**R7613** Storage Oscilloscope ..... **$6,110**

### OPTIONS (7613)

**Option 01** — Without CRT Readout ..... **−$350**

**Option 03** — EMC Capability ..... **+$375**

**Option 05** — Line Frequency Change (50 Hz to 400 Hz) ..... **+$300**

**Option 06** — Special Internal Graticule (Spectrum Analyzer) ..... **+$50**

**Option 08** — Protective Panel Cover ..... **+$100**

### OPTIONS (R7613)

**Option 01** — Without CRT Readout ..... **−$350**

**Option 03** — EMC Capability ..... **+$375**

**Option 05** — Line Frequency Change (50 Hz to 400 Hz) ..... **+$300**

**Option 06** — Special Internal Graticule (Spectrum Analyzer) ..... **+$50**

### CONVERSION KITS (7613)

**CRT Readout** — Order 040-0656-02 ..... **$650**

**EMC Capability** — Order 040-0663-01 ..... **$375**

**X-Y Horizontal Comp** — Order 040-0718-00 ..... **$390**

**Power Supply** — To Light Plug-in Pushbuttons. Order 040-0686-01 ..... **$70**

### CONVERSION KITS (R7613)

**CRT Readout** — Order 040-0676-02 ..... **$650**

**EMC Capability** — Order 040-0678-01 ..... **$375**

**Power Supply** — To Light Plug-in Pushbuttons. Order 040-0686-01 ..... **$70**

### INTERNATIONAL POWER CORDS AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

**Option A5** — Switzerland 220 V/10 A, 50 Hz

# 7000 SERIES PLUG-INS

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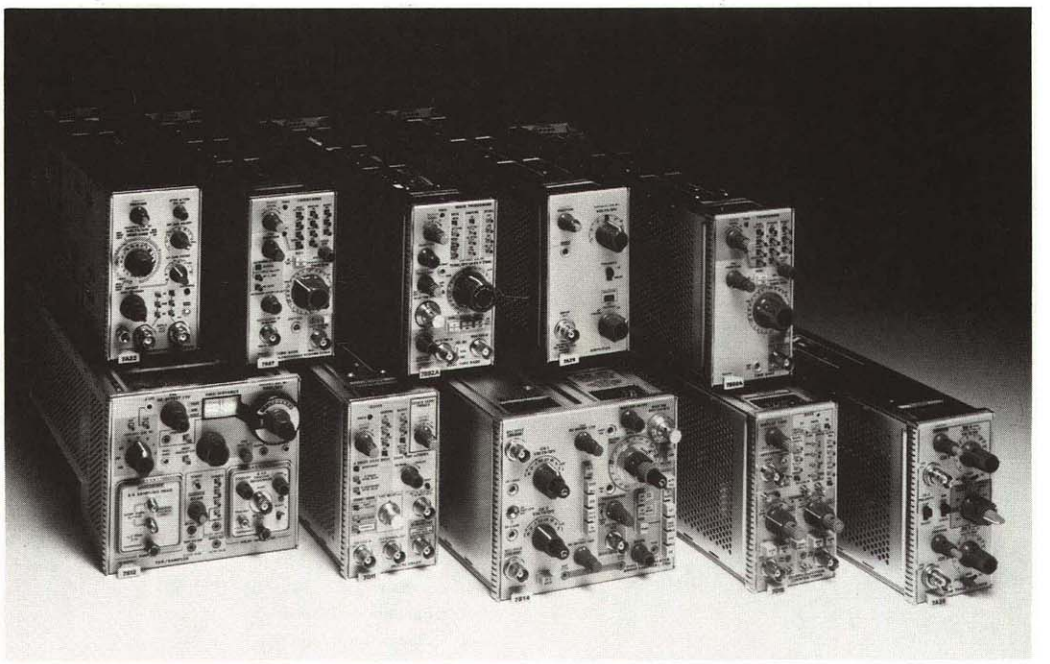
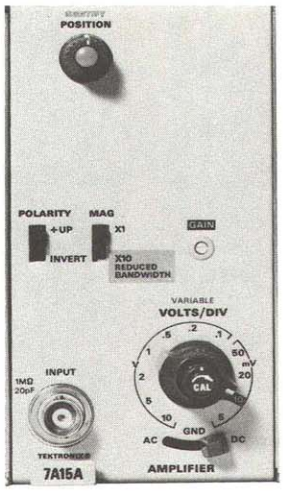


For the 7000 Series, you can select from over forty different plug-in units—single-trace and dual-trace amplifiers, differential comparators, samplers, logic analyzers, spectrum analyzers, trigger recognizers, waveform digitizer, curve tracer, universal counter/timer, digital multimeter, digital delay unit, a wide range of time-bases, and others. This variety lets you tailor your instrument to meet your immediate need—for the most exotic application—and then expand its capabilities later as your needs change.

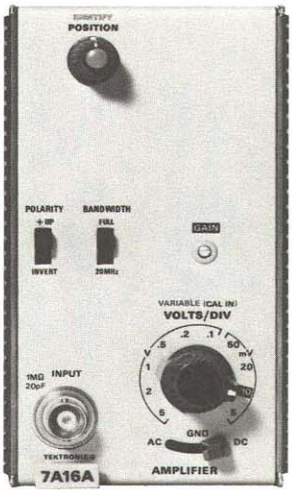
**Tektronix offers service training classes on various 7000 Series plug-ins. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.**

**7A15A**



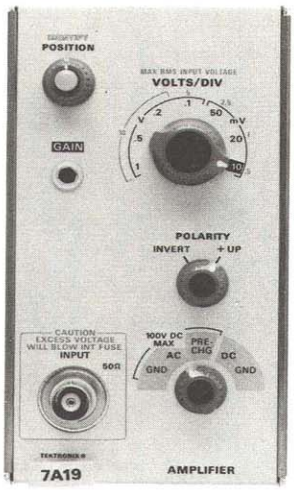

**Dc to 80 MHz Amplifier**

**7A16A**



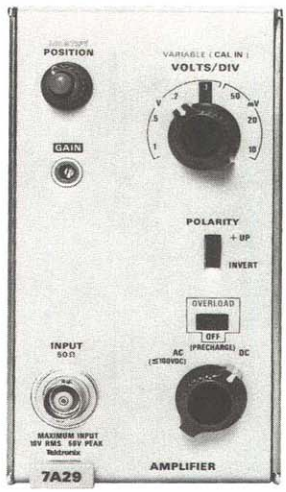

**Dc to 225 MHz Amplifier**

**7A19**




**Dc to 600 MHz Amplifier**

**7A29**




**Dc to 1 GHz Amplifier**

## 7A15A

### Dc to 80 MHz Bandwidth

### 5 mV/div to 10 V/div Calibrated Deflection Factors

### 500 μV/div at 10 MHz (10X Gain)

### 1 MΩ Input

The 7A15A is a single-trace amplifier which provides a bandwidth of 80 MHz in the 7800, 7900, and 7100 Series mainframes. (See page 231 for bandwidth in other 7000 Series mainframes.) Bandwidth is constant over the entire range of deflection sensitivities of 5 mV/div to 10 V/div. A 10X gain amplifier provides 500 μV sensitivity with a bandwidth of 10 MHz. Polarity of the display is selectable by a front-panel switch.

#### CHARACTERISTICS

**Deflection Factor** — 5 mV/div to 10 V/div in 11 calibrated steps (1-2-5 sequence). X1 gain accuracy is within 2% with X1 gain adjusted at 10 mV/div. X10 gain (increases sensitivity to 500 μV) accuracy is within 10% at 10 MHz bandwidth throughout deflection factor settings. Uncalibrated variable is continuous between steps to at least 25 V/div.

**Input R and C** — 1 MΩ within 2%; ≈20 pF.

**Maximum Input Voltage** — Dc Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum 1 kHz or less. Ac Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less.

**Included Accessory** — Instruction manual.

#### ORDERING INFORMATION

**7A15A** Amplifier ..... **$655**

For floating measurements, order A6902A Isolator. See page 434 for complete description.

## 7A16A

### Dc to 225 MHz Bandwidth

### 5 mV/div to 5 V/div Calibrated Deflection Factors

### 1 MΩ Input

The 7A16A is a single-trace amplifier which provides a bandwidth of 225 MHz in the 7900 and 7100 Series mainframes. (See page 231 for bandwidth in other 7000 Series mainframes.) Bandwidth is constant over the entire range of deflection sensitivities of 5 mV/div to 5 V/div. Bandwidth may be limited to 20 MHz to reduce displayed noise in lower-frequency applications. Polarity of the display is selectable by a front panel switch.

#### CHARACTERISTICS

**Deflection Factor** — 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 10 mV/div. Uncalibrated variable is continuous between steps to at least 12.5 V/div.

**Input R and C** — 1 MΩ within 2%; ≈20 pF.

**Maximum Input Voltage** — Dc Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. Ac Coupled: 500 V (dc + peak ac); ac component 500 V p-p maximum, 1 kHz or less.

**Dc Stability** — Drift with ambient temperature (constant line voltage) is 0.02 div/°C. Drift with time (ambient temperature and line voltage constant) is 0.02 div in any one minute after 1 hour warm-up.

**Included Accessory** — Instruction manual.

#### ORDERING INFORMATION

**7A16A** Amplifier ..... **$1,200**

## 7A19

### Dc to 600 MHz Bandwidth

### 10 mV/div to 1 V/div Calibrated Deflection Factors

### 50 Ω Input

### Optional ±500 ps Variable Delay Line

The 7A19 is a high-performance, wide-band, single-trace amplifier which provides a bandwidth of 600 MHz in the 7100 Series mainframes. (See page 231 for bandwidths in other 7000 Series mainframes.) Bandwidth is constant over the entire range of deflection sensitivities of 10 mV/div to 1 V/div. Input impedance is 50 Ω. Polarity of the display is selectable by a front-panel switch. An optional variable delay line (front-panel adjustable) permits matching the transit time of two 7A19s and/or probes to better than 50 ps.

#### CHARACTERISTICS

**Deflection Factor** — 10 mV/div to 1 V/div in seven calibrated steps (1-2-5 sequence). Accuracy is within 3%.

**Input R** — 50 Ω.

**Option 04, Variable Signal Delay** — Permits matching the transit time of two preamps and probes to better than 50 ps. Range is ±500 ps.

**Maximum Input** — 50 div peak or 10 V RMS (2 W), whichever is less, in the dc-coupled mode 100 V dc additional in the ac-coupled mode.

**Included Accessory** — Instruction manual.

#### ORDERING INFORMATION

**7A19** Amplifier ..... **$2,730**

**Option 04** — Variable Signal Delay ..... **+$415**

For recommended probes refer to pages 230 and 440.

## 7A29

### Dc to 1 GHz Bandwidth

### 10 mV/div to 1 V/div Calibrated Deflection Factors

### 50 Ω Input

### Optional ±500 ps Variable Delay Line

The 7A29 is a high-performance, wide-band, single-trace amplifier which provides a bandwidth of 1 GHz in the 7100 Series mainframes. (See page 231 for bandwidths in other 7000 Series mainframes.) Bandwidth is constant over the entire range of deflection sensitivities of 10 mV/div to 1 V/div. Input impedance is 50 Ω. Manually resettable input protection circuitry protects the input against most common overloads. Polarity of the display is selectable by a front-panel switch. An optional variable delay line (front-panel adjustable) permits matching the transit time of two 7A29s and/or probes to better than 10 ps.

#### CHARACTERISTICS

**Deflection Factor** — 10 mV/div to 1 V/div in seven calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 0.1 V/div. Uncalibrated variable is continuous between steps to at least 2.5 V/div with some bandwidth reduction.

**Input R** — 50 Ω.

**Ac Coupling** — −3 dB at 1 kHz or less from a 50 Ω source.

**Option 04, Variable Signal Delay** — Permits matching the transit time of two preamps and probes to better than 10 ps. Range is ±500 ps.

**Maximum Input** — 10 V RMS or 1 W-second pulses not exceeding 50 V peak in dc coupled mode. 100 V dc additional in ac coupled mode.

**Input Protection** — Internal detection circuitry provides protection by automatically disconnecting excessive signals of up to 50 V. The "disconnected" condition is indicated, and has manual reset.

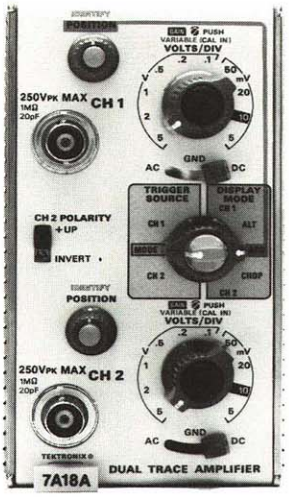
**Included Accessory** — Instruction manual.

#### ORDERING INFORMATION

**7A29** Amplifier..... **$2,855**

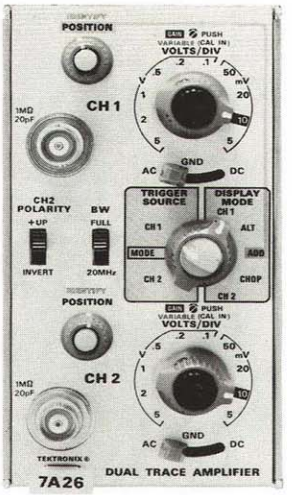
**Option 04** — Variable Signal Delay ..... **+$415**

**7A18A**



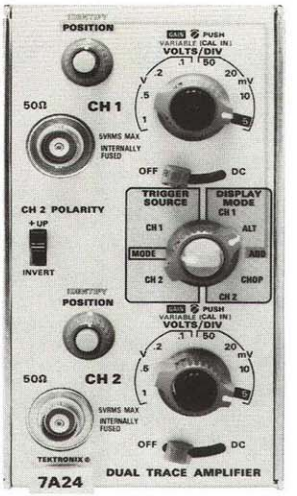

**Dc to 75 MHz Dual Trace Amplifier**

**7A26**




**Dc to 200 MHz Dual Trace Amplifier**

**7A24**




**Dc to 400 MHz Dual Trace Amplifier**

## 7A18A

### Dc to 75 MHz Bandwidth

### 5 mV/div to 5 V/div Calibrated Deflection Factors

### 1 MΩ Input

### Optional Dc Offset

The 7A18A is a dual-trace amplifier which provides a bandwidth of 75 MHz in all 7000 Series mainframes. Bandwidth is constant over the entire range of deflection sensitivies of 5 mV/div to 5 V/div. The 7A18A features five operating modes, trigger source selectability, and a trace-identify function. Polarity of Channel 2 display is selectable by a front-panel switch to allow difference measurements between signals.

#### CHARACTERISTICS

**Deflection Factor** — Calibrated: 5 mV/div to 5 V/div in ten steps (1-2-5 sequence). Accuracy: Within 2% with gain adjusted to 10 mV/div. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.

**Input R and C** — 1 MΩ within 2%; ≈20 pF.

**Maximum Input Voltage** — Dc Coupled: 250 V (dc + peak ac); ac component 500 V p-p maximum, 1 kHz or less. Ac Coupled: 500 V (dc + peak ac); ac component 500 V p-p maximum, 1 kHz or less.

**Dc Stability** — Drift with Ambient Temperature (Constant Line Voltage): 0.01 div/°C. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 div in any one minute after 1 hr warm-up.

**Common-Mode Rejection Ratio (Add, CH 2 Invert)** — At least 10:1, dc to 50 MHz.

**Included Accessory** — Instruction manual.

#### DC OFFSET OPTION

Dc Offset is for the user who needs to analyze small signals that are riding on larger signals, such as power supply ripple.

**Option 06, Dc Offset** — Separate Channel 1 and Channel 2 variable Offset controls are concentric with the position controls replacing the identify push-buttons of the standard 7A18A. The ac-dc-ground switch of each channel is expanded to accommodate a fourth position for dc offset.

**Offset Range Display** — ±200 division maximum, equivalent to ±1 V at 5 mV/div.

**Accuracy** — When in dc Offset the deflection accuracy is derated by 1%.

#### ORDERING INFORMATION

**7A18A** Amplifier ..... **$1,290**

**Option 06** — Dc Offset ..... **+$200**

For floating measurements, order A6902A Isolator. See page 434 for complete description.

## 7A26

### Dc to 200 MHz Bandwidth

### 5 mV/div to 5 V/div Calibrated Deflection Factors

### 1 MΩ Input

The 7A26 is a dual-trace amplifier which provides a bandwidth of 200 MHz in the 7900 and 7100 Series mainframes. (See page 231 for bandwidth in other 7000 Series mainframes.) Bandwidth is constant over the entire range of deflection sensitivities of 5 mV/div to 5 V/div. Bandwidth may be limited to 20 MHz to reduce displayed noise in lower-frequency applications. The 7A26 features five operating modes, trigger source selectivity, and trace-identify. Polarity of Channel 2 is selectable by a front-panel switch to allow difference measurements between signals.

#### CHARACTERISTICS

**Deflection Factor** — Calibrated: 5 mV/div to 5 V/div in ten steps (1-2-5 sequence). Accuracy: Within 2% with gain adjusted at 10 mV/div. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.

**Input R and C** — 1 MΩ within 2%; ≈22 pF.

**Maximum Input Voltage** — Dc Coupled: 250 V (dc + peak ac); ac component 500 V p-p maximum, 1 kHz or less. Ac Coupled: 500 V (dc + peak ac); ac component 500 V p-p maximum, 1 kHz or less.

**Common-Mode Rejection Ratio (Add, CH 1 Invert)** — At least 10:1, dc to 50 MHz.

**Dc Stability** — Drift with Ambient Temperature (Constant Line Voltage): 0.02 div/°C. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 division in any one minute after 1 hr warm-up.

**Included Accessory** — Instruction manual.

#### ORDERING INFORMATION

**7A26** Amplifier ..... **$2,155**

For recommended probes refer to pages 230 and 440.

## 7A24

### Dc to 400 MHz Bandwidth

### 5 mV/div to 1 V/div Calibrated Deflection Factors

### 50 Ω Input

The 7A24 is a high-performance, wide-band, dual-trace amplifier which provides 400 MHz bandwidth in the 7100 Series mainframes. (See page 231 for bandwidth in other 7000 Series mainframes.) Bandwidth is constant over the entire range of deflection sensitivies from 5 mV/div to 1 V/div. Input impedance is 50 Ω. The 7A24 features five operating modes, trigger source selectivity, and trace identify. Polarity of Channel 2 display is selectable by a front panel switch to allow difference measurements between signals.

#### CHARACTERISTICS

**Deflection Factor** — Calibrated: 5 mV/div to 1 V/div in eight steps (1-2-5 sequence). Accuracy: Within 2% with gain adjusted to 5 mV/div. Uncalibrated: Variable is continuous between steps to at least 2.5 V/div.

**Input R** — 50 Ω within 0.5%; vswr 1.25:1 or less at 5 mV/div and 10 mV/div, 1.15:1 or less from 20 mV/div to 1 V/div at 250 MHz.

**Maximum Input Voltage** — 5 V RMS; 0.5 W maximum input power, internally protected.

**Common-Mode Rejection Ratio** — At least 10:1, dc to 50 MHz.

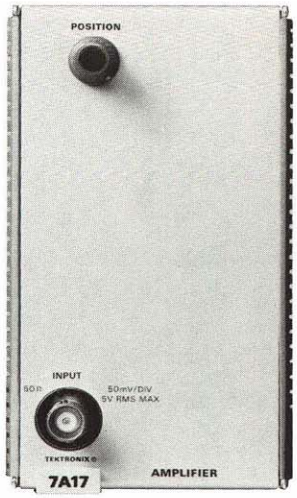
**Dc Stability** — Drift with Ambient Temperature (Constant Line Voltage): 0.02 div/°C. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 div in any one minute after 1 hr warmup.

**Included Accessory** — Instruction manual.

#### ORDERING INFORMATION

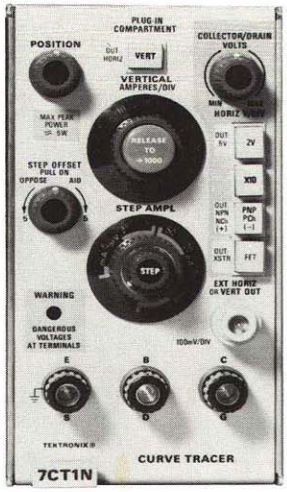
**7A24** Amplifer ..... **$2,435**

**7A17**



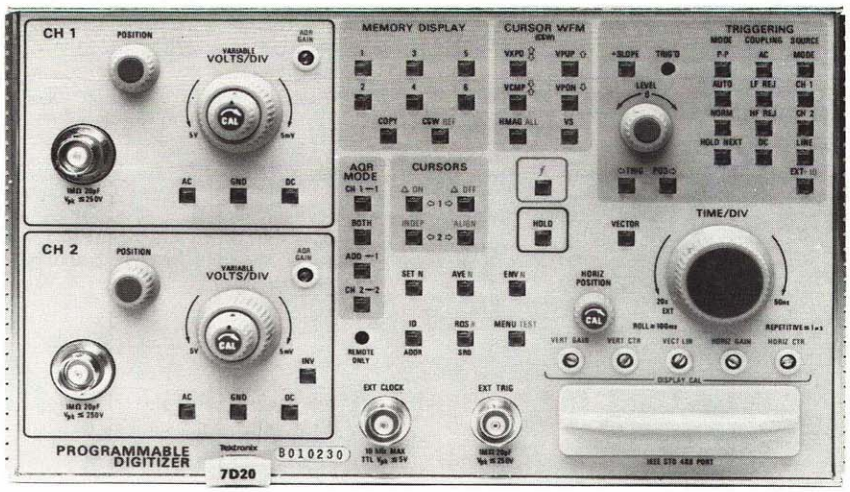

Amplifier

**7CT1N**




Curve Tracer

**7D20**




Programmable Digitizer

## 7A17

**Dc to 150 MHz Bandwidth**

**Low Cost**

**50 mV/div Calibrated Deflection Factor**

**Easy to Customize**

The 7A17 is a basic, 150 MHz single-channel amplifier with provision for the addition of user-developed circuitry for special unique applications.

The layout of the circuit board assembly provides a blank soldering pad matrix and ground plane surface totaling approximately 40 square inches. Circuits may be installed here. Mainframe power is identified and available on the circuit board. The front sub-panel is prepunched with holes of various sizes and shapes which allow for the mounting of connectors, switches, indicators, etc.

### CHARACTERISTICS

**Deflection Factor** — Adjustable to 50 mV/div. There is no step attenuation.

**Input Z** — 50 Ω.

**Maximum Input Voltage** — 5 V RMS.

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**7A17** Amplifier ..... **$430**

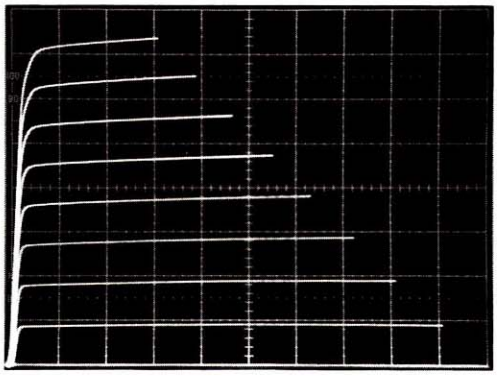
For floating measurements, order A6902A Isolator. See page 434 for complete description.

## 7CT1N

**10 nA/div to 20 mA/div Vertical Deflection Factors**

**0.5 V/div to 20 V/div Horizontal Deflection Factors**

The 7CT1N converts your 7000 Series oscilloscope into a semiconductor curve tracer capable of displaying characteristics of small-signal devices to power levels up to 0.5 W. The 7CT1N operates in either the horizontal or vertical compartments of any 7000 Series mainframe. It may be used in conjunction with standard amplifier and time-base plug-in units to display signal waveforms along with characteristic curve families.



*2N3904 transistor characteristic generated by the 7CTIN. Control settings are indicated on front panel of 7CTIN.*
*Vertical — 20 mA/div*
*Horizontal — 0.5 V/div*
*Base Current — 10 μA/step*

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**7CT1N** Curve Tracer ..... **$1,550**

**For more Information on the 7CT1N see page 410 in Curve Tracer section.**

GPIB IEEE-488

## 7D20

The 7D20 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**Digital Storage for 7000 Series Mainframe**

**70 MHz Bandwidth for Repetitive Signals**

**10 MHz Single-Shot Bandwidth**

**Two Channels Simultaneous Acquisition**

**Totally Programmable**

**Storage of Six Independent Waveforms**

**Enveloping and Signal Averaging**

**Cursor Measurements**

**Pretrigger and Posttrigger**

The 7D20 brings state-of-the-art digital performance to Tektronix 7000 Series mainframes and rackmounts. See page 333 for complete description. (Not recommended for use in the 7104 and R7103 mainframes).

7A13

**Differential Comparator Amplifier**

## 7A13

**Dc to 105 MHz Bandwidth**

**1 mV/div to 5 V/div Calibrated Deflection Factors**

**20,000:1 CMRR**

**10,000 cm Effective Screen Height**

**1 MΩ Input Switchable to ∞**

The 7A13 is a differential comparator amplifier which provides dc to 105 MHz bandwidth in all the 7900 Family instruments. It incorporates a number of features which make it particularly versatile, especially in multitrace combination with other 7000 Series vertical plug-ins.

The 7A13 has constant bandwidth over the 1 mV/div to 5 V/div deflection factor range. The bandwidth is selectable to Full or 5 MHz for best displayed noise conditions for low-frequency applications.

As a differential amplifier the 7A13 provides a balanced (+ and −) input for applications requiring rejection of a common-mode signal. The CMRR is 20,000:1 from dc to 100 kHz, derating to 200:1 at 20 MHz. The unit can reject up to 10 V of common-mode signal at a deflection factor setting of 1 mV/div, increasing to 100 V at 10 mV/div (X10 Vc pulled) and 500 V at 0.1 V/div.

As a comparator amplifier the 7A13 provides an accurate (0.1%) positive or negative internal offsetting voltage of up to ±10 V. This precision offset voltage effectively provides a screen height of 10,000 div at 1 mV/div. The offset voltage is also available as an output for external monitoring.

### CHARACTERISTICS

**Input R and C** — 1 MΩ within 0.15%; ≈20 pF. $R_{in}$ ≈∞ is available in the 1 mV to 50 mV/div range, selectable by an internal switch.

**Deflection Factor** — 1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 1.5% with gain adjusted at 1 mV/div. Uncalibrated variable is continuous between steps to at least 12.5 V/div.

**Signal Range**

| Deflection Factor Settings | 1 mV to 50 mV/div | 10 mV to 50 mV/div (X10 Vc out) and 0.1 V to 0.5 V/div | 0.1 V to 0.5 V/div (X10 Vc out) and 1 V to 5 V/div |
|---|---|---|---|
| Common-mode Signal | ±10 V | ±100 V | ±500 V |
| Maximum Dc Coupled Input (dc + Peak Ac at 1 kHz or less) | ±40 V | ±400 V | ±500 V |
| Maximum Ac Coupled Input (dc Voltage) | | ±500 V | |

**Maximum Input Gate Current** — 0.2 nA or less from 0°C to +35°C; 2 nA or less at +35°C to +50°C.

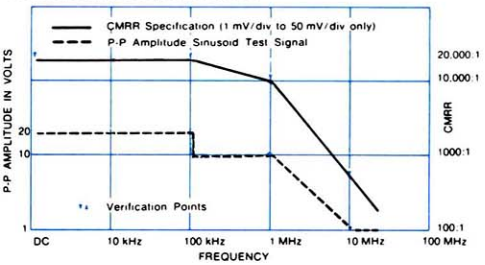
**Dc Stability** — Drift with Time (Constant Ambient Temperature and Line Voltage): Short term is 1 mV p-p or 0.1 div, or less (whichever is greater) over any 1-minute interval after 20 minute warm-up. Long term is 1 mV p-p or 0.1 div or less (whichever is greater) during any 1 hr interval after 20 minute warm-up. Drift with Ambient Temperature (Constant Line Voltage): 2 mV/10°C to 0.2 div/10°C or less, whichever is greater.

**Displayed Noise (Tangentially Measured)** — With X10 Vc in, 400 μV (200 μV RMS) or less at 1 mV/div; 0.2 div or less at 2 mV/div to 5 mV/div; 0.05 div or less at 10 mV/div to 5 V/div. With X10 Vc out, 0.4 div or less at 10 mV/div to 0.5 V/div.

**Overdrive Recovery** — 1 μs to recover to within 2 mV and 0.1 ms to recover to within 1 mV after a pulse of ±10 V or less at 1 mV/div only, regardless of pulse duration.

**Internal Comparison Voltage** — Range: 0 V to ±10 V; Accuracy: ±(0.1% of setting +3 mV); Vc Output R: ≈15 kΩ.

**Common-Mode Rejection Ratio**




At least 2000:1, 10 mV/div to 50 mV (X10 Vc out) and 0.1 V/div to 5 V/div. Ac coupled input at least 500:1 at 60 Hz.

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**7A13** Amplifier ..... **$3,135**

## P6055 20,000:1 CMRR 10X with Readout

**High CMRR**

**Compact Size**

**Low Capacitance**

**Dc to 60 MHz**

The P6055 is a miniature, low-capacitance, 10X probe designed for use with Tektronix differential amplifiers with nominal input capacitances from 20 pF to 47 pF. The attenuation ratio is adjustable to compensate for differences in input resistance of the amplifier (the amplifier input resistance must be 1 MΩ ± 2%). A special locking type readout connector allows the probe to be used with instruments with or without readout capability.

When two P6055 Probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other is helpful in maintaining the CMRR of the system. The use of a matched pair of P6055 differential probes provide the best possible system CMRR.

### CHARACTERISTICS

**CMRR** — 20,000:1 from dc to 1 kHz derating to 100:1 at 20 MHz. **Attenuation** — Adjustable to 10X. **Input Resistance** — 1 MΩ ±0.5%. **Input Capacitance** — ≈10 pF when used with instrument that has 20 pF input capacitance; 12.5 pF when used with instrument that has 47 pF input capacitance. **Maximum Useful Bandwidth** — 60 MHz. **Typical Probe Risetime** — 5.8 ns. **Maximum Voltage** — 500 V (dc + peak ac) from dc to 12 MHz. P-p voltage derates to 100 V at 70 MHz.

**INCLUDED ACCESSORIES**

Retractable hook tip (BB, 013-0107-03); 13 cm (5 inch) ground lead (175-0124-01); probe holder (352-0090-00); two electrical insulating sleeves (BP, 166-0404-01); two alligator clips (AS, 344-0046-00); adjustable tool (CP, 003-0675-01); hook tip (BU, 206-0114-00); 13 cm (6 inch) electrical ground lead (DF, 175-1256-00); 30 cm (12 inch) ground lead (175-0125-01); instruction manual.

### ORDERING INFORMATION

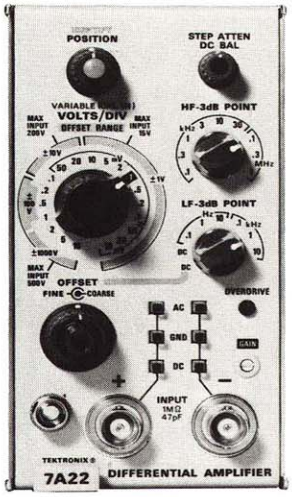
**P6055** 10X, 3.5 ft, Differential Probe. Order 010-6055-01 ..... **$275**

**Matched Pair** of P6055 Probes. Order 015-0437-00 ..... **$485**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

For recommended probes refer to pages 230 and 440.

**7A22**




**Differential Amplifier**

## 7A22

**Dc to 1 MHz Bandwidth**

**10 μV/div to 10 V/div Calibrated Deflection Factors**

**100,000:1 CMRR**

**Selectable Upper and Lower −3 dB Points**

**Dc Offset**

**10 μV/Hour Dc Drift*[1]**

**1 MΩ Input**

The 7A22 is a high-gain differential amplifier well suited for difficult low-amplitude, low-frequency measurements. Selectable high and low pass filters help eliminate unwanted noise and drift from the display and from the triggering signal.

### CHARACTERISTICS

**Bandwidth** — HF: −3 dB point; selectable in nine steps (1-3 sequence) from 100 Hz to 1 MHz, accurate within 10% of selected frequency; risetime in 1 MHz position is 350 ns ±9%. LF: −3 dB point; selectable in six steps (1-10 sequence) from 0.1 Hz to 10 kHz, accurate within 12% of selected frequency. The switch also contains dc and dc with Offset positions. Ac coupled at input, 2 Hz or less.

**Deflection Factor** — 10 μV/div to 10 V/div in 19 calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted to 1 mV/div. Uncalibrated variable is continuous between steps to at least 25 V/div.

**Input R and C** — 1 MΩ within 1%; ≈47 pF.

**Maximum Input Gate Current** — Differentially measured, 40 pA (+25°C) and 200 pA (+50°C) at 10 μV/div to 10 mV/div; 10 pA (+25°C) and 20 pA (+50°C) at 20 mV/div to 10 V/div.

Single ended, one-half the differential measurement. Display shift is ±4 division (+25°C) and ±20 division (+50°C) at 10 μV/div (ac coupled).

**Signal and Offset Range**

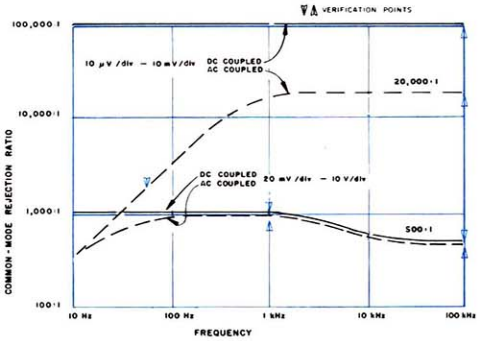
| Deflection Factor Settings | 10 μV to 10 mV/div | 20 mV to 0.1 V/div | 0.2 V to 1 V/div | 2 V to 10 V/div |
|---|---|---|---|---|
| Common-Mode Signal Range | ±10 V | ±100 V | ±500 V | |
| Maximum Dc Coupled Input (dc + peak ac at 1 kHz or less) | ±15 V | ±200 V | ±500 V | |
| Maximum Ac Coupled Input (dc voltage) | ±500 V dc rejection, at least 4 x $10^5$:1 | | | |
| Dc Offset Range | +1 V to −1 V | +10 V to −10 V | +100 V to −100 V | +1000 V to −1000 V |

**Dc Stability** — Drift with Time (Constant Ambient Temperature and Line Voltage): Short term is 5 μV (p-p) or 0.1 div, whichever is greater in any minute after one hour warm-up. Long term is 10 μV (p-p) or 0.1 div, whichever is greater in any hour after one hour warm-up. Drift with Ambient Temperature (Constant Line Voltage): 50 μV/°C or less.

**Displayed Noise** — 16 μV or 0.1 div (whichever is greater) at maximum bandwidth; source resistance 25 Ω or less measured tangentially.

**Overdrive Recovery** — 10 μs or less to recover within 0.5% of zero level after removal of a test signal applied for 1 s (signal amplitude not to exceed differential dynamic range). Front-panel Overdrive light indicates that an overdrive condition is being approached.

**Common-Mode Rejection Ratio (for signals not exceeding common-mode signal range)**




**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

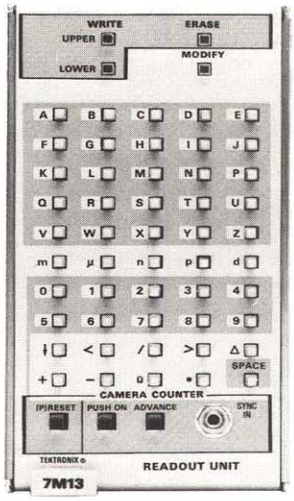
**7A22** Amplifier ..... **$1,640**

### High CMRR Differential Probes

Matched pair of P6055 probes for maximum CMRR. (See page 254 for P6055 Characteristics.)
Order 015-0437-00 ..... **$485**

*[1] With constant temperature. See dc stability specifications.*

**7M13**



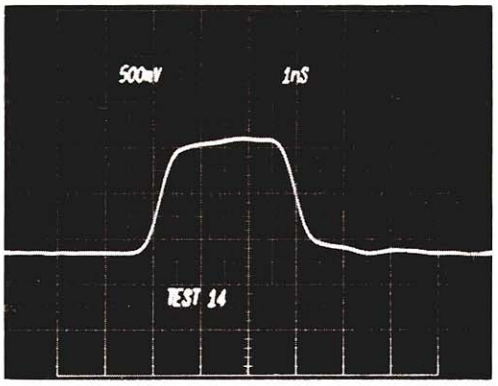

**Readout Unit**

## 7M13

**Easy and Convenient Identification of Photographed Displays**

**Automatic Sequence Advance with Each Camera Exposure**

The 7M13 Readout Unit provides front-panel keyboard operation of the Tektronix 7000-Series oscilloscope CRT readout characters. Up to ten user-selected alphanumeric characters can be displayed at the top and at bottom of the CRT. A remote-advance cable is supplied with the 7M13 to connect it to the shutter X-sync connector of the C-50 Series cameras. An optional cable is available for cameras using an ASA connector for X-sync.




*The photograph above was identified as TEST 14 by using the 7M13 in 7834 Storage Oscilloscope.*

**INCLUDED ACCESSORIES**

Remote-advance cable (012-0339-01); instruction manual.

### ORDERING INFORMATION

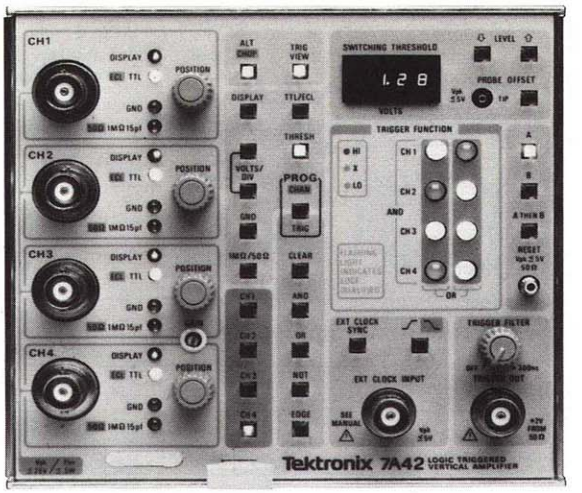
**7M13** Readout Unit ..... **$1,190**

**Optional Accessory** — Remote-advance cable with ASA connector for camera X-sync (required with Tektronix C-30 Series cameras). Order 012-0364-01 ..... **$25**

For recommended probes refer to pages 230 and 440.

# 7A42

- Up to 350 MHz Bandwidth (7100 Family)
- Four Input Channels
- Boolean Logic Triggering
- Nested Trigger Functions
- Variable Switching Thresholds
- Precise Amplitude and Timing Measurement
- External Clock Synchronization
- 1 MΩ/50 Ω Switchable Inputs
- Variable/Bias Offset Probe Compatibility
- 7000 Series Mainframe Compatible




The 7A42 Logic Triggered Vertical Amplifier is a two-wide 7000 Series plug-in that provides a significant new dimension to oscilloscope measurements through the combination of oscilloscope and logic analyzer technologies. The 7A42 logic triggering permits digital signals to be displayed in analog form for high resolution measurements of both time and amplitude characteristics.

### High Resolution Analog Display of Digital Signals

Very accurate analog representations of digital signals are displayed. Input attenuators can be optimized for either TTL or ECL logic families. A 1 ns risetime with 200 ps or less delay difference between the four input channels provides precise, high resolution timing measurements. Unlike a logic analyzer's timing display, the 7A42 accurately displays risetimes and falltimes, allows pulse width to be precisely measured, enables pulse aberrations to be viewed and quantified, and amplitude to be measured with confidence.

### Advanced Logic Triggering

Triggers are generated by the 7A42 upon recognition of preprogrammed Boolean combinations of logic levels and transitions at any or all of its input channels. Independently variable switching thresholds and edge sensitivity make triggering on digital signals an easy task.

### Nested Triggering Functions

One level of nested triggering is implemented in the 7A42. Triggers may be generated on event "A", event "B", or on "A then B". In "A then B" mode, the 7A42 arms on event A, and generates a trigger to a time base on the next occurrence of event B. A reset input disarms the 7A42 in nested triggering mode at any time. Nested triggering provides the flexibility needed to trigger on even the most complex digital event.

### See The Trigger Event

Delay lines in the 7A42 permit the trigger event to be displayed in its entirety. A representation of the 7A42 Trigger Out signal can be displayed on the mainframe CRT. This Trigger View trace shows where the trigger event occurred and how long it lasted.

### Trigger Filtering Prevents Inadvertent Triggering

A continuously variable (equal to or greater than 300 ns) trigger filter control eliminates unnecessary or inadvertent triggering by requiring that a trigger function remain true longer than the Trigger Filter setting.

### External Clock Synchronization

An external clock input allows further qualification of a triggering event to coincide with either a positive or negative transition of an external clock signal. This input is compatible with either TTL or ECL levels.

### Special Probe Features

The 7A42 Probe Offset accommodates the P6230 Variable Bias/Offset Probe, which is ideal for probing ECL circuits with reduced loading. The P6230 is a 1.5 GHz, 450 Ω probe with the ability to place bias voltage at its tip. A wide variety of accessories, including very flexible grounding schemes, make the P6230 ideal for high speed digital circuit testing. The P6131 10X high impedance probe is the recommended probe for TTL, high speed TTL, CMOS and other high impedance logic families.

### Easy Setup

CRT readout of attenuator settings and the display of error messages designed to guide a user through the process of setting up the instrument make the 7A42 easy to operate. The use of multicolored LEDs communicate the status of other 7A42 functions at a glance. A battery backup system preserves the current settings when power is removed and reapplied, thus saving setup time.

## CHARACTERISTICS

### VERTICAL SYSTEM

**Input** — Four channels, BNC connectors.

**Deflection Factor** — Calibrated Through 10X Probe: TTL (CMOS) family is 1, 2, 5 V/div. ECL family is 0.2, 0.5, 1 V/div. Gain Accuracy: Within 3%.

**Bandwidth** — To 350 MHz maximum. See 7000 Series Vertical System Specifications on page 231 for frequency response in specific mainframes.

**Input Impedance** — Selectable between 1 MΩ and 50 Ω. High Impendance: 1 MΩ ±1%, in parallel with ≈15 pF. Low Impedance: 50 Ω ±1 Ω at dc. Vswr is ≤1.15:1, dc to 300 MHz.

**Maximum Input Voltage** — 1 MΩ: 25 V (dc + peak ac) 36 MHz or less, derated linearly to 3 V (peak ac) at 300 MHz. 50 Ω: 5 V RMS during any 1 ms time interval. Active internal-protection opens all inputs if overvoltage is applied to any channel.

**Dc Stability** — Drift with Time: Not more than 0.2 div in any 10 min after 20 min warmup. Drift with Temperature: Not more than 0.2 div for 10°C ambient change.

**Differential Delay** — 200 ps maximum between the four input channels.

**Trigger View or External Clock View** — Time Coincidence with Channel Display: Trigger View is within 3 ns. External Clock View is within 5 ns.

### TRIGGER SYSTEM

**Switching Threshold** — Voltage Range*1 : TTL (CMOS) family is +12.8 V to −12.7 V. ECL family is +2.56 V to −2.54 V. Accuracy*1: TTL (CMOS) family is ±50 mV ±2% of setting. ECL family is ±10 mV ±2% of setting.
Presets*1: TTL (CMOS) is +1.4 V. ECL is −1.3 V. Probe Offset activated is 0 V.

**Tip (Probe Offset) Input** — Maximum Voltage Range: +5.1 V to −5.1 V, dc only. DVM Accuracy: ±20 mV ±2% of reading.

**Trigger Filter** — Range: Off, or adjustable from <15 ns to >300 ns. Match, Trigger Function A to Trigger Function B: Within 20% at maximum setting.

**Ext Clock Input** — Maximum Voltage Range: +5 V to −5 V (dc + peak ac). Threshold: Two Ext Clock Input modes are available, TTL or ECL. TTL level at logic zero is ≤0.8 V; at logic one is ≥2 V. ECL level at logic zero is ≤−1.5 V; at logic one is ≥−1.1 V. Input Impedance: TTL level is ≈10 KΩ in parallel with ≈55 pF, terminated to +5 V, compatible with a 1X probe. ECL level is ≈50 Ω, terminated to −2 V. Pulse Width: TTL level is 20 ns minimum, either pulse transition selected. ECL level is 5 ns minimum, leading pulse transition selected; or 10 ns minimum, trailing pulse transition selected. Setup Time: 10 ns minimum. Hold Time: 10 ns minimum.

**Channel Edge Sensitivity** — Setup Time, Channel to Channel: 5 ns minimum (time that level sensitive portion of trigger function must be true before Edge sensitive channel transition). Hold Time, Channel to Channel: 5 ns minimum, (time that level sensitive portion of trigger function must remain true after Edge sensitive channel transition). Setup Time, Edge Sensitive Channel: 10 ns minimum (time that level of Edge sensitive channel must be stable before transition). Hold Time, Edge Sensitive Channel: 5 ns minimum (time that level of Edge sensitive channel must remain stable after transition).

**Trigger Out Connector** — Output Voltage: 1 V into 50 Ω. Output Impedance: ≈50 Ω. Toggle Frequency: 125 MHz maximum. Propagation Delay: Channel Input to Trigger Output is 25 ns or less. A then B Mode: Time between A and B is 5 ns minimum (minimum setup time from event A to event B). Time from B to A is 5 ns minimum (minimum time after event B to next event A). Event Duration (minimum time to insure proper arming and triggering): Event A is 5 ns minimum. Event B is 5 ns minimum. Front panel A then B Gate Output: Active only if selected and in the A then B mode.

*1 *At tip of 10X probe with readout compensation.*

**Mainframe A Then B Gate Output** — Active only in A then B mode. Pulse Width (Measured at the 50% Points): > the time between event A and event B by 5 ns ±2 ns.

**Reset Input** — Maximum Input Voltage: +5 V to −5 V (dc + peak ac). Input Impedance: ≈50 Ω. Logic Zero Level: ≤0.2 V. Logic One Level: ≥0.8 V. Pulse Width: 100 ns minimum. Timing (Post-Reset Inhibit Time to Next Trigger): 10 ns minimum (time from falling edge of Reset to next recognizable event). Response Time: Reset pulse must lead or be coincident with event recognition to inhibit trigger output. Event recognition must lead the Reset pulse by 10 ns to guarantee trigger output.

**BATTERY BACKUP**

**Ni-Cad Battery (3.75 V)** — Provides power to preserve front panel control status a minimum of 200 hours while main power is off. Battery requires about 24 hours to fully charge from discharged condition.

**OTHER CHARACTERISTICS**

**Net Weight** — ≈2.8 kg (6.2 lb).

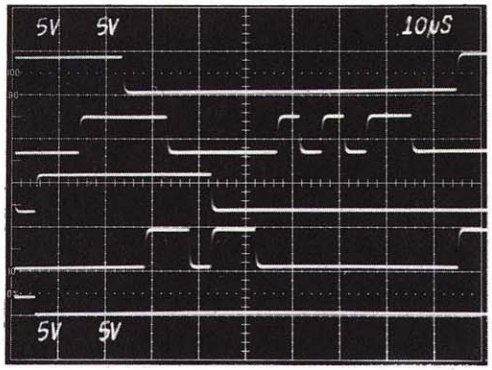
**Shipping Weight** — ≈7.2 kg (16.0 lb).

**Included Accessories** — Instruction manual.

**ORDERING INFORMATION**

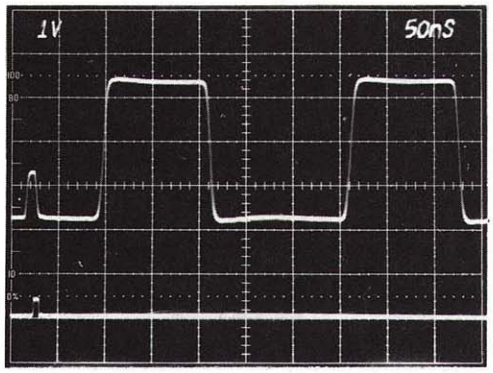
**7A42** Logic Triggered Vertical Amplifier **$6,070**

### Four Channel Analog Display with Trigger View



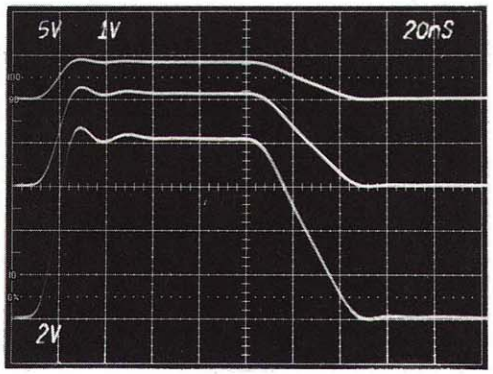

*Up to four logic signals can be displayed by the 7A42 in true analog form. Additionally, the Trigger View trace provides the ability to view exactly when the programmed Trigger Function is satisfied.*

### Selective Triggering on a Low Amplitude Pulse



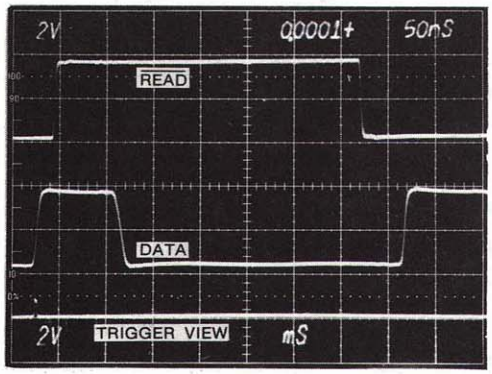

*Independent and variable trigger thresholds for each of the four input channels allow selective triggering on an abnormally low amplitude pulse (indeterminate state) within a pulse train. Shown above, two channels are used to establish dual thresholds to bracket the low level pulse. The 7A42 triggers on any signal that remains between the two thresholds longer than the time set by the Trigger Filter.*

### Range of Sensitivities




*Three display sensitivities are available for each of the logic families. Select the most convenient display size for the application; small amplitudes for many traces on the screen, or large sizes when more signal detail is desired.*

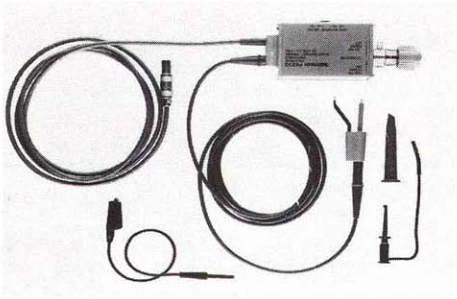
### Edge Sensitive Triggering




*Data bus transitions are generally not allowed during a specified time at the end of a microprocessor read cycle. In the above display, the 7A42 has captured a positive transition of a data line during the time when data should have been stable (note trigger view pulse). The 7A42's Edge Sensitivity enhances its Boolean triggering by detecting rising or falling transitions of one signal during a time qualified by the states of the other channels.*

## OPTIONAL ACCESSORIES

### P6230 Variable Bias/Offset 10X Probe



*The P6230 probe is recommended for high speed ECL probing. It is a very low capacitance, high bandwidth, probe ideal for ECL and features a variable bias/offset that minimizes its dc loading on the circuit. See page 441 for details.*

**ORDERING INFORMATION**

**P6230** 10X Probe ..... **$395**

### P6131 10X Passive Probe

*The P6131 is a general purpose probe, ideal for use with TTL and CMOS circuits, and is recommended for use with the 7A42 for up to 300 MHz system bandwidth. See page 452 for details.*

**ORDERING INFORMATION**

**P6131** 10X Passive Probe ..... **$140**

# 7B80/7B85/7B87

**1 ns/div to 5 s/div Calibrated Time Bases**

**Triggering to 400 MHz**

**Variable Trigger Holdoff**

**Peak-to-Peak Auto Triggering**

**7B85 Features:**

**ΔTime Measurements with CRT Readout**

**Delayed Time Measurements with CRT Readout**

**Vertical Trace Separation Between Two Delayed Sweeps**

**7B87 Features:**

**Pretrigger when used with 7854**

The 7B80, 7B85 and 7B87 are horizontal time bases recommended for use with 7700, 7800 and 7900 Series mainframes to provide optimum bandwidth/sweep-speed compatibility. (Each may be used in any slower 7000 Series mainframe with some reduction in sweep accuracy at the fastest sweep speed.)

Each plug-in can be used separately as an independent single time base, or combined in any mainframe with two horizontal compartments for delaying and delayed operation.

X-Y displays are available using a 7B80 with Option 02. A front-panel button (Display Mode) selects normal sweep or X-Y display. Both signals are applied to vertical (Y) amplifiers, and the desired horizontal (X) signal is then routed through plug-in and mainframe trigger paths to the 7B80. An X-Y mode selection then applies the signal to the horizontal deflection system. This option is appropriate where the user is making Y-T and X-Y measurements, and changing the amplifier frequently from the vertical to the horizontal compartment is not acceptable.

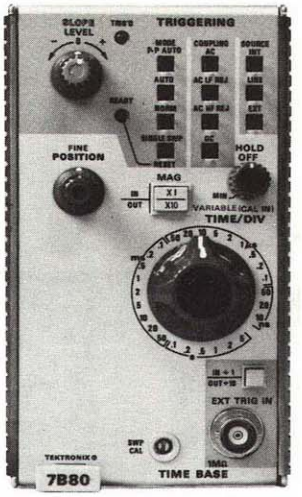
The 7B87 is designed for use with the 7854 mainframe to provide additional pretrigger capability. The pretrigger feature is compatible only with the 7854 at this time. When used in the B horizontal of the 7854, the 7B87 provides both single shot and pretrigger capability to the 7854.

Pretrigger allows you to view what has occurred before the trigger event in single shot applications. The amount of pretrigger time is determined by the Acquire-Stop delay time setting. The total amount of pretrigger is 0.2 to 9.9 times the time/div setting.

The Int ÷ 1000 control reduces the stored time/div to 1000 times slower than the real time display on a 7854. This does not, however, affect the Acquire-Stop delay time. The Int ÷ 1000 control allows stored sweep speeds from 10 ms to 5000 s/div for slow speed applications.

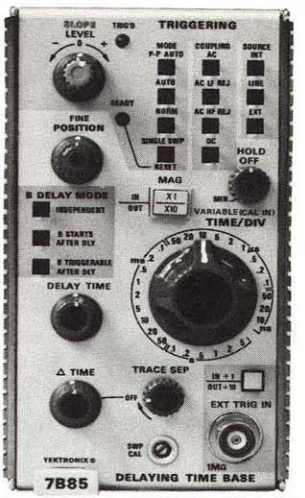
An Ext Clock-In connector is provided for clock frequencies other than that offered by the Int clock of the 7B87.

**7B80**




**Delayed Time Base**

**7B85**




**ΔDelaying Time Base**

**7B87**

**Time Base**

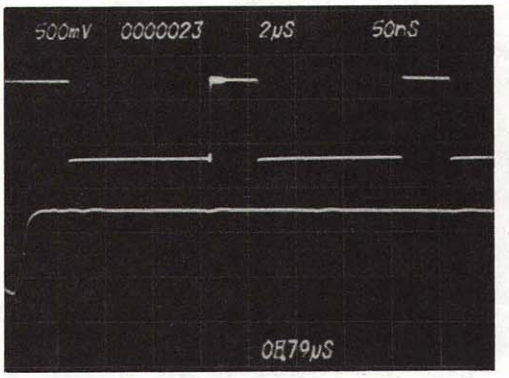



*Figure 1. Delaying and delayed sweeps are shown with the mainframe selecting Alt sweep modes. The delay time to the start of the delayed sweep is digitally presented on the lower edge of the CRT.*

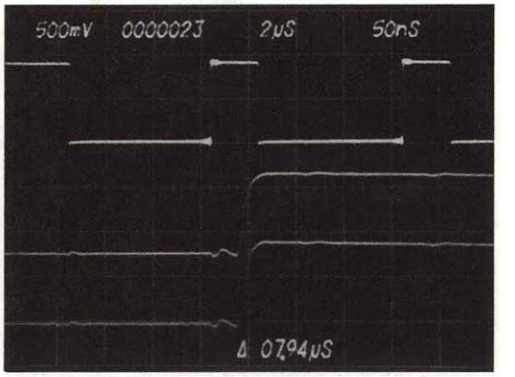



*Figure 2. With the mainframe still selecting Alt sweeps, delaying and both delayed sweeps are shown. The digital readout on the lower CRT edge shows the time between the two sweep delays. The Trace Separation knob is used to position the second delayed sweep below the first delayed sweep with up to 3 division of separation.*

## CHARACTERISTICS

Characteristics are common to all three units unless otherwise noted.

**Sweep Rates** — 5 s/div to 10 ns/div in 27 steps (1-2-5 sequence). X10 Magnifier extends fastest calibrated sweep rate to 1 ns div. The uncalibrated variable is continuous to at least 2.5 times the calibrated sweep rate.

**Sweep Accuracy** — Measured over the center 8 divisions, +15°C to +35°C, in the 7700, 7800, or 7900 Series mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

| Time/Div*1 | Unmagnified | Magnified |
|---|---|---|
| 5 s/div to 1 s/div | 4.0% | Unspecified |
| 0.5 s/div to 50 ns/div | 1.5% | 2.5% |
| 20 ns/div to 10 ns/div | 2.5% | 4.0% |

**1 Fastest calibrated sweep rate is limited by 7700 and 7600.*

**Trigger Holdoff Time**

| | | |
|---|---|---|
| Minimum Holdoff Setting | 5 s/div to 1 μs/div | 2 times Time/Div setting or less |
| | 0.5 μs/div to 10 ns/div | 2.0 μs or less |
| Variable Holdoff Range | Extends holdoff time through at least 2 sweep lengths for rates of 20 ms/div or faster | |

**ΔTime Range** — 0 to at least 9.0 times Time/Div setting (7B85 only).

**ΔTime Accuracy (+15°C to +35°C)** — 0.5 s/div to 50 ms/div: Within (0.5% of reading +0.1% full scale +1 count)*1. 20 ms/div to 100 ns/div: Within (0.5% of reading +0.03% full scale +1 count)*1. (7B85 only.)

**1 Full scale equals 10 times the Time/Div switch setting.*

**Trace Separation Range** — Functional only in ΔDelay Time mode when alternating or chopping between time-base units. The second delayed sweep display can be vertically positioned at least 3 division below the first delayed sweep display (7B85 only).

**Delay Time** — Range: 0.2 or less to at least 9.0 times Time/Div setting. Jitter: 0.02% of Time/Div setting plus 0.1 ns, or less (7B85 only).

### TRIGGERING

**Triggering Sensitivity (Auto and Norm Modes)*1**

| Coupling | Triggering Frequency Range*2 | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|---|
| Ac | 30 Hz to 50 MHz<br>50 MHz to 400 MHz | 0.3 div<br>1.5 div | 50 mV<br>250 mV |
| Ac LF Rej*3 | 30 kHz to 50 MHz<br>50 MHz to 400 MHz | 0.3 div<br>1.5 div | 50 mV<br>250 mV |
| Ac HF Rej | 30 Hz to 50 kHz | 0.3 div | 50 mV |
| Dc*4 | Dc to 50 MHz<br>50 MH to 400 MHz | 0.3 div<br>1.5 div | 50 mV<br>250 mV |

**1 From repetitive signals.*

**2 Triggering frequency ranges are limited to the frequency of the vertical system when operating in the Internal mode.*

**3 Will not trigger on sinewaves of less than 8 division Internal, or 3 V External, at or below 60 Hz.*

**4 Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the Auto Triggering mode.*

**Single Sweep** — Requirements are same as for repetitive inputs.

**Internal Trigger Jitter** — 0.1 ns or less at 400 MHz.

**Triggering Sensitivity**[*1]

| Triggering Frequency Range | Min Signal Required | |
|---|---|---|
| | Int | Ext |
| Low Frequency Response: At least 50 Hz | 2.0 div | 500 mV |
| 200 Hz to 50 MHz | 0.5 div | 125 mV |
| 50 MHz to 400 MHz | 1.5 div | 375 mV |

*[*1] P-P Auto Mode (ac or dc coupling).*

**External Trigger Input** — Maximum Input Voltage: 250 V (dc + peak ac). Input R and C: 1 MΩ within 5% and 20 pF within 10%. Level Range (Excluding P-P Auto): At least ±1.5 V in Ext ÷ 1, and at least ±15 V in Ext ÷ 10.

**Internal Clock** — Pretrigger: 0.02048 Hz to 20.45 MHz determined by the Time/Div, X10 magnification and ÷ 1000 switches. Accuracy of Internal and Internal ÷ 1000 = 0.1% (7B87 only).

**External Clock** — Maximum Input: 5 V peak. Input R: 100 kΩ within 5%. Threshold voltage TTL compatible. Maximum input frequency 10 MHz with BNC input. Delay 0.5 μs or less (7B87 only).

**Acquire Stop Delay** — Total Range: 0.2 or less to at least 9.9 times Time/Div setting. Jitter (5 s/div to 10 μs/div): 0.02% of Time/Div setting or less. Delay Accuracy (+15°C to +35°C): From 0.5 s/div to 10 μs/div is within 0.5% of measurement plus 5% of Time/Div setting (7B87 only).

**Single Shot Performance** — Using 7B87 with 7854 Internal Clock (7B87 only).

| Fastest Sweep (Time/Div) | Points/Waveform |
|---|---|
| 50 μs | 128 |
| 100 μs | 256 |
| 200 μs | 512 |
| 500 μs | 1024 |

**7B80 Option 02, X-Y Phase Shift (Determined by the Circuitry in Mainframe)** — For mainframe without X-Y horizontal compensation, the mainframe phase shift specifications are retained for frequencies of 50 kHz and below. For mainframes with optional X-Y horizontal compensation, the extra delay adds to the phase shift error above 50 kHz. For example, a 7904A Option 02 would have 2° of phase shift at 1 MHz and the total phase shift would be 4°.

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**7B80** Time Base ..... **$1,530**

**Option 02** — X-Y Horizontal Compensation ..... **+$100**

**7B85** Delaying Time Base ..... **$1,755**

**7B87** Time Base (for use with 7854) ..... **$1,695**

**7B92A**

**Dual Time Base**

## 7B92A

**0.5 ns/div to 0.2 s/div Calibrated Time Base**

**Triggering to 500 MHz**

**Alternate Display of Intensified Delaying and Delayed Sweeps**

**Contrast Regulation Between Delaying and Delayed Sweeps**

The 7B92A Dual Time Base is recommended for use in the 7100, 7800 and 7900 Series mainframes. (The 7B92A may be used in all other mainframes at slower sweep speeds.)

There are four display modes: normal sweep, intensified delaying sweep, delayed sweep, and alternate sweep (no alternate sweep in R7704). When operating in the Auto mode of main triggering, a bright base line is displayed in the absence of a trigger signal.

### CHARACTERISTICS

#### DELAYING SWEEP (MAIN SWEEP)

**Sweep Rate** — 0.2 s/div to 10 ns/div in 23 calibrated steps (1-2-5 sequence). An uncalibrated variable rate is continuous between steps, and extends sweep rate to at least 0.5 s/div. The variable control is internally switchable between delaying and delayed sweeps.

**Sweep Accuracy** — Measured over the center 8 div in a 7900 Family oscilloscope:

| Time/Div | +15°C to +35°C | 0°C to +50°C |
|---|---|---|
| 0.2 s/div to 20 ns/div | Within 2% | Within 3% |
| 10 ns/div | Within 3% | Within 4% |

**Delay Time Multiplier Range** — 0 to 9.8 times the Dly Time/Div setting from 0.2 s/div to 10 ns/div (0 s to 1.96 s).

**Delay Time Jitter**[*1]

| | |
|---|---|
| 0.2 s/div to 50 μs/div | 1 part in 50,000 of the maximum available delay time |
| 20 μs/div to 10 ns/div | 1 part in 50,000 of the maximum available delay time +0.5 ns |

*[*1] Not applicable for the first 2% of maximum available delay time (Delay Time Mult dial setting >0.2). Maximum available delay time is 10 times the Time/Div or Dly Time switch setting.*

**Differential Delay Time Measurement Accuracy**[*1]

| Sweep Speed | | |
|---|---|---|
| 0.2 s/div to 0.1 μs/div | Both Delay Time Mult dial settings at 0.5 or greater | ±(0.75% of reading +0.25% of full scale[*2]) |
| | One or both Delay Time Mult dial settings at less than 0.5 | ±(0.75% of reading +0.5% of full scale[*2] +5 ns) |
| 50 ns/div to 10 ns/div | Both delay times equal to or greater than 25 ns | ±(1% of reading +0.5% of full scale[*2]) |
| | One or both delay times less than 25 ns | ±(1% of reading +1% of full scale[*2] +5 ns) |

*[*1] +15°C to +35°C.*

*[*2] Full scale is 10 times the Time/Div or Dly Time setting. Accuracy applies over the center 8 div from +15°C to +35°C.*

#### MAIN TRIGGERING

**Auto, Norm**

| Coupling | Triggering Frequency Range | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|---|
| Ac | 30 Hz to 20 MHz<br>20 MHz to 500 MHz | 0.5 div<br>1.0 div | 100 mV<br>500 mV |
| Ac LF Rej | 30 kHz to 20 MHz<br>20 MHz to 500 MHz | 0.5 div<br>1.0 div | 100 mV<br>500 mv |
| Ac HF Rej | 30 Hz to 50 kHz | 0.5 div | 100 mV |
| Dc | Dc to 20 MHz<br>20 MHz to 500 MHz | 0.5 div<br>1.0 div | 100 mV<br>500 mV |

**HF Sync** — Triggering sensitivity is 0.5 div Int or 100 mV Ext, from 100 MHz to 500 MHz for any coupling except Ac HF Rej.

**Single Sweep** — Triggering requirements are the same as normal sweep. When triggered, time base produces one sweep only until reset.

**Internal Trigger Jitter** — 50 ps or less at 500 MHz.

**External Trigger Input** — Selectable 50 Ω or 1 MΩ inputs (1 MΩ is paralleled by ≈20 pF). Maximum safe input is 250 V (dc + peak ac) for 1 MΩ input and 1 W average for 50 Ω input. Range of trigger level is at least ±3.5 V in Ext, and at least ±35 V in Ext ÷ 10.

#### DELAYED SWEEP

**Sweep Rate** — 0.2 s/div to 0.5 ns/div in 27 steps (1-2-5 sequence). An uncalibrated variable rate is continuous between steps, and extends sweep rate to at least 0.5 s/div. The variable control is internally switchable between delaying and delayed sweeps.

**Sweep Accuracy** — Measured over the center eight divisions in a 7900 Family oscilloscope:

| Time/Div | +15°C to +35°C | 0°C to +50°C |
|---|---|---|
| 0.2 s/div to 20 ns/div | Within 2% | Within 3% |
| 10 ns/div to 5 ns/div | Within 3% | Within 4% |
| 2 ns/div to 1 ns/div | Within 4% | Within 5% |
| 0.5 ns/div | Within 5% | Within 6% |

**Delayed Triggering**

| Coupling | Triggering Frequency Range | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|---|
| Ac | 30 Hz to 20 MHz<br>20 MHz to 500 MHz | 0.5 div<br>1.0 div | 100 mV<br>500 mV |
| Dc | Dc to 20 MHz<br>20 MHz to 500 MHz | 0.5 div<br>1.0 div | 100 mV<br>500 mV |

**Internal Trigger Jitter** — 50 ps or less at 500 MHz.

**External Trigger Input** — Selectable 50 Ω or 1 MΩ inputs (1 MΩ is paralleled by ≈20 pF). Maximum Safe Input: 250 V (dc + peak ac) for 1 MΩ input, and 1 W average for 50 Ω input. Range of Trigger Level: At least ±3.5 V in Ext.

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**7B92A** Dual Time Base ..... **$3,575**

# 7B10/7B15

**0.2 ns/div to 0.2s/div Calibrated Time Bases**

**Triggering to 1 GHz**

**Variable Trigger Holdoff**

**Peak-to-Peak Auto Triggering**

**7B15 Features:**

**ΔTime Measurements with CRT Readout**

**Delayed Time Measurements with CRT Readout**

**Vertical Trace Separation Between Two Delayed Sweeps**

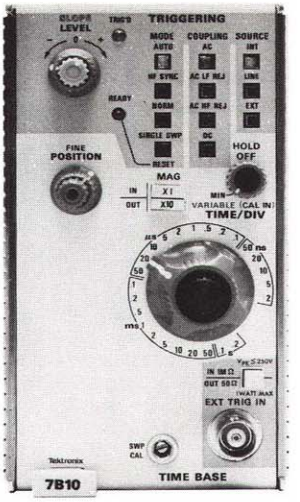
The 7B10 and 7B15 are horizontal time bases designed for use with the 7000 Series mainframes to provide optimum bandwidth/sweep-speed compatibility, but may also be used with the 7700, 7800, and 7900 Series mainframes. (Each may be used in any slower 7000 Series mainframe with some reduction in sweep accuracy at the fastest sweep speed.)

Either plug-in can be used separately as an independent single time base, or they can be combined in any mainframe with two horizontal compartments for delaying and delayed operation.

The 7B10 and 7B15 (and the 7B80 and 7B85) provide the Δtime measurement in addition to the standard delay time display.

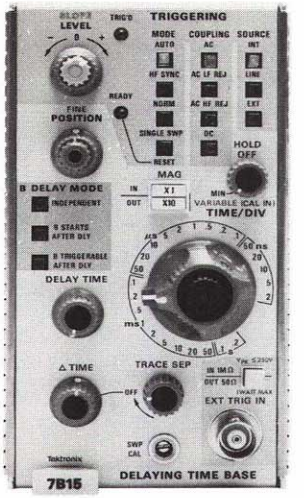
Delta time measurement is accomplished simply by manually positioning two intensified zones on the waveform. The time difference between the two zones is displayed in the CRT readout. (See waveform photos on page 258.) Expansion and overlapping of the two intensified zones is possible to allow very precise setting of the zones to the desired points on the displayed waveform.

**7B10**




**Delayed Time Base**

**7B15**




**ΔDelaying Time Base**

## CHARACTERISTICS

**Sweep Rates** — 0.2 s/div to 2 ns/div in 25 steps. X10 Magnifier extends fastest calibrated sweep rate to 0.2 ns/div. The uncalibrated variable is continuous to at least 2.5 times the calibrated sweep.

**Sweep Accuracy** — Measured over the center 8 div, +15°C to +35°C, in the 7100, 7800 or 7900 Series mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

| Time/Div*1 | Unmagnified | Magnified |
|---|---|---|
| 0.2 s/div to 10 ns/div | 2% | 3% |
| 5 ns/div and 2 ns/div | 3% | 4% |

**1 Fastest calibrated sweep rate is limited by 7900, 7800, 7700, 7600 and 7300 Series mainframes.*

**Trigger Holdoff Time**

| | Minimum | Maximum with Variable |
|---|---|---|
| 0.2 s/div to 50 ms/div | 40 ms | 400 ms |
| 20 ms/div to 2 μs/div | X2 the Time/Div Setting | X20 the Time/Div Setting |
| 1 μs/div to 0.5 μs/div | 2 μs | 20 μs |
| 0.2 μs/div to 2 ns/div | 2 μs | 6 μs |

**ΔTime Range** — 0 to at least 9.0 times Time/Div setting.

**ΔTime Accuracy** — Within (0.5% of reading +3 counts) 20 ms/div to 100 ns/div.

**Trace Separation Range** — Functional only in ΔDelay Time mode when alternating or chopping between time base units. The second delayed sweep display can be vertically positioned at least three divisions below the first delayed sweep display.

**Delay Time Range** — 0.2 or less to at least 9.0 times Time/Div setting.

**Jitter** — 0.02% of Time/Div setting up through 50 μs/div. 0.03% of Time/Div setting plus 0.1 ns for sweep speeds of 20 μs/div through 100 ns/div.

**TRIGGERING**

**Triggering Sensitivity**

| Coupling | Triggering Frequency Range*1 | Minimum Triggering Signal Required: Int | Minimum Triggering Signal Required: Ext |
|---|---|---|---|
| Ac | 30 Hz to 250 MHz<br>250 MHz to 1 GHz | 0.5 div<br>1.5 div | 50 mV<br>150 mV |
| Ac LF Rej*2 | 50 kHz to 250 MHz<br>250 MHz to 1 GHz | 0.5 div<br>1.5 div | 50 mV<br>150 mV |
| Ac HF Rej | 30 Hz to 40 kHz | 0.5 div | 50 mV |
| Dc*3 | Dc to 250 MHz<br>250 MHz to 1 GHz | 0.5 div<br>1.5 div | 50 mV<br>150 mV |

**1 The triggering frequency ranges given here are limited to the −3 dB frequency of the oscilloscope vertical system when operating in the Internal mode.*

**2 Will not trigger on sine waves at or below 60 Hz when amplitudes are <8 division Internal or 3 V External.*

**3 The Triggering Frequency Range for Dc Coupling applies to frequencies above 30 Hz when operating in the Auto Triggering Mode.*

**Single Sweep** — Requirements are the same as for repetitive inputs.

**Internal Trigger Jitter** — 30 ps or less at 1 GHz.

**HF Sync Mode** — 250 MHz to 1 GHz 0.3 div Internal and 0.75 mV External.

**External Trigger Input** — Maximum input voltage is 250 V (dc + peak ac) for 1 MΩ input, 1 W average for 50 Ω input. Input R and C for 1 MΩ input is 1 MΩ within 5%, 20 pF within 10%; for 50 Ω input, 50 Ω within 2%. Level range is at least ±3.5 V in Ext ÷ 1.

**Included Accessory** — Instruction manual.

## ORDERING INFORMATION

**7B10** Time Base ..... **$2,380**

**7B15** Delaying Time Base ..... **$2,695**

# 7B53A/7B50A

**5 ns/div to 5 s/div Calibrated Time Base**

**Single Sweep Operation**

**Calibrated Mixed Sweep (7B53A)**

**Optional TV Sync Separator Triggering (7B53A)**

**Triggering to 100 MHz (7B53A) and 150 MHz (7B50A)**

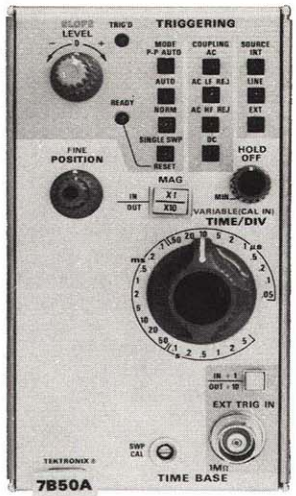
**Variable Trigger Holdoff (7B50A)**

**P-P Auto Triggering (7B50A)**

**7B53A**

**Dual Time Base**

**7B50A**




**Time Base**

The easy-to-use 7B53A and 7B50A Time Bases are recommended for use with 7600 Series mainframes to provide optimum bandwidth/sweep speed compatibility. They may, however, be used in any 7000 Series mainframe. The fastest sweep rate (5 ns/div) is obtained with the X10 Magnifier.

The 7B53A provides normal, intensified delaying, delayed, and mixed sweep.

## CHARACTERISTICS (7B53A)

### DELAYING SWEEP

**Sweep Rate** — 50 ns/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 Magnifier. The uncalibrated Variable is continuous between steps. The variable control is internally switchable between main, delayed-sweep, and variable main-sweep holdoff.

**Sweep Accuracy**[*1]

| Time/Div | Unmagnified | | Magnified | |
|---|---|---|---|---|
| | +15°C to +35°C | 0°C to +50°C | +15°C to +35°C | 0°C to +50°C |
| 5 s/div to 1 s/div | 3% | 4% | Unspecified | Unspecified |
| 0.5 s/div to 0.05 μs/div | 3% | 4% | 3.5% | 5% |
| 50 ms/div to 0.5 μs/div | 2% | 3% | 2.5% | 4% |

*[*1] Measured over the center 8 divisions.*

**Delay Time Multiplier Range** — 0 to 10 times the Delay Time/Div setting from 5 s/div to 1 μs/div.

**Differential Delay Time Measurement Accuracy** — 5 s/div to 1 s/div: ±1.4% of measurement +0.3% of full scale. 0.5 s/div to 1 μs/div: ±0.7% of measurement +0.3% of full scale. Full scale is 10 times the Delay Time/Div setting. Accuracy applies over the center 8 DTM div from +15°C to +35°C.

**Jitter** — 0.05% or less of Time/Div setting.

**Triggering Sensitivity**

| Coupling | Triggering Frequency Range | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|---|
| Ac | 30 Hz to 10 MHz<br>10 MHz to 100 MHz | 0.3 div<br>1.5 div | 100 mV<br>500 mV |
| Ac LF Rej[*1] | 30 kHz to 10 MHz<br>150 kHz to 10 MHz<br>10 MHz to 100 MHz | 0.3 div<br>——<br>1.5 div | ——<br>100 mV<br>500 mV |
| Ac HF Rej | 30 Hz to 50 kHz | 0.3 div | 100 mV |
| Dc | Dc to 10 MHz<br>10 MHz to 100 MHz | 0.3 div<br>1.5 div | 100 mV<br>500 mV |

*[*1] Will not trigger on sinewaves of 3 div or less Int or 1.5 V Ext below 120 Hz.*

**Single Sweep** — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until reset.

**Internal Trigger Jitter** — 1 ns or less at 75 MHz.

**External Trigger Input** — Maximum Input Voltage: 500 V (dc + peak ac), 500 V p-p ac at 1 kHz or less. Input R and C: 1 MΩ within 2%, 20 pF within 2 pF. Level Range: At least +1.5 V to −1.5 V in Ext, at least +15 V to −15 V in Ext ÷ 10.

### DELAYED SWEEP

**Sweep Rate** — 0.05 μs/div to 0.5 s/div in 22 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 Magnifier. The uncalibrated variable is continuous between steps to at least 1.25 s/div and is switchable between the main, delayed sweep, and variable main sweep holdoff.

**Sweep Accuracy**[*1]

| Time/Div | Unmagnified | | Magnified | |
|---|---|---|---|---|
| | +15°C to +35°C | 0°C to +50°C | +15°C to +35°C | 0°C to +50°C |
| 0.5 s/div to 0.1 s/div and 0.2 μs/div to 0.05 μs/div | 4% | 5% | 4.5% | 6% |
| 50 ms/div to 0.5 μs/div | 3% | 4% | 3.5% | 5% |

*[*1] Measured over the center 8 divisions.*

**Delayed Sweep Gate** — Output Voltage: ≈ +3.5 V into at least 10 kΩ shunted by 100 pF or less, or 0.5 V into 50 Ω. Rise-time: 50 ns or less. Output R is 350 Ω within 10%. Gate is available at the Dly'd Trig In connector when the delayed sweep source switch is set to Int.

**Triggering Sensitivity**

| Coupling | Triggering Frequency Range | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|---|
| Ac | 30 Hz to 10 MHz<br>10 MHz to 100 MHz | 0.3 div<br>1.5 div | 100 mV<br>500 mV |
| Dc | Dc to 10 MHz<br>10 MHz to 100 MHz | 0.3 div<br>1.5 div | 100 mV<br>500 mV |

**Internal Trigger Jitter** — 1 ns or less at 75 MHz.

**External Trigger Input** — Maximum Input Voltage: 500 V (dc + peak ac), 500 V p-p ac at 1 kHz or less. Input R and C: 1 MΩ within 2%, 20 pF within 2 pF. Level Range: At least +1.5 V to −1.5 V in Ext.

### MIXED SWEEP

**Sweep Accuracy** — Within 2% plus measured main sweep error. Exclude the following portions of mixed sweep: First 0.5 div after start of main sweep display and 0.2 div or 0.1 μs (whichever is greater) after transition of main to delayed sweep.

### EXT HORIZONTAL INPUT

**Deflection Factor** — 10 mV/div within 10% when in Ext, Mag X10; 100 mV/div within 10% when in Ext; 1 V/div within 10% when in Ext ÷ 10.

**Bandwidth**

| Coupling | Lower −3 dB | Upper −3 dB |
|---|---|---|
| Ac | 40 Hz | 2 MHz |
| Ac LF Rej | 16 kHz | 2 MHz |
| Ac HF Rej | 40 Hz | 100 kHz |
| Dc | Dc | 2 MHz |

### TV SYNC

**Option 05, TV Sync Separator Triggering** — Permits stable internal line or field rate triggering from displayed composite video or composite sync waveforms. Conventional waveform displays and measurements can be made from standard broadcast or closed circuit TV systems, domestic or international, with up to 1201-line, 60 Hz field rates. Individual lines may be displayed with delayed sweep features. The wide range of delayed sweeps permits accurate alternate-frame, color-burst observations in the PAL color system. Option 05 deletes ac line trigger and Ext ÷ 10 from trigger source.

**Included Accessory** — Instruction manual.

## CHARACTERISTICS (7B50A)

**Sweep Rates** — 0.05 μs/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 Magnifier. The uncalibrated variable allows continuous sweep rate selection between steps.

**Sweep Accuracy**[*1]

| Time/Div | Unmagnified | Magnified |
|---|---|---|
| 5 s/div to 1 s/div | 4% | Unspecified |
| 0.5 s/div to 0.5 μs/div | 2% | 3% |
| 0.2 μs/div to 0.05 μs/div | 3% | 4% |

*[*1] Measured over center 8 div, +15°C to +35°C, with any 7000 Series mainframe. Derate accuracies by an additional 1% each for 0°C to +50°C.*

**Trigger Holdoff Time**

| | | |
|---|---|---|
| Minimum Holdoff Setting | 5 s/div to 1 μs/div | 2 times Time/Div setting or less |
| | 0.5 μs/div to 50 ns/div | 2.0 μs or less |
| Variable Holdoff Range | Extends holdoff time through at least 2 sweep lengths for sweep rates of 20 ms/div or faster | |

**Triggering Sensitivity**[*1]

| Coupling | Triggering Frequency Range[*2] | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|---|
| Ac | 30 Hz to 50 MHz<br>50 MHz to 150 MHz | 0.3 div<br>1.5 div | 50 mV<br>250 mV |
| Ac LF Rej[*3] | 30 kHz to 50 MHz<br>50 MHz to 150 MHz | 0.3 div<br>1.5 div | 50 mV<br>250 mv |
| Ac HF Rej | 30 Hz to 50 kHz | 0.3 div | 50 mV |
| Dc[*4] | Dc to 50 MHz<br>50 MHz to 150 MHz | 0.3 div<br>1.5 div | 50 mV<br>250 mV |

*[*1] Auto and Norm modes.*

*[*2] Triggering frequency ranges are limited to the frequency of the vertical system when operating in the Int mode.*

*[*3] Will not trigger on sinewaves of <8 div Int, or 3 V Ext, at or below 60 Hz.*

*[*4] Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the Auto Triggering mode.*

**Triggering Sensitivity**[*1]

| Triggering Frequency Range | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|
| 200 Hz to 50 MHz | 0.5 div | 125 mV |
| 50 MHz to 150 MHz | 1.5 div | 375 mV |

*[*1] P-p Auto Mode ac or dc coupling.*

**Single Sweep** — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until reset.

**Option 02, X-Y Phase Shift (Determined by the Circuitry in Mainframe)** — For mainframes without X-Y horiz compensation, the mainframe phase shift specification is retained for frequencies of 50 kHz and below. For mainframes with optional X-Y horizontal compensation, the extra delay adds to the phase shift error above 50 kHz.

**Included Accessory** — Instruction manual.

## ORDERING INFORMATION

**7B53A** Dual Time Base ..... **$1,560**

**Option 05** — TV Triggering ..... **+$150**

**7B50A** Time Base ..... **$975**

**Option 02** — X-Y Horizontal Compensation ..... **+$100**

**7D11**

**Digital Delay Unit**

# 7D11

**Delay by Time or Events**

**Digital Delay Readout to 7½ Digits**

**100 ns to 1 s Delay Time**

**1 ns Resolution**

**2.2 ns Delay Time Jitter**

**0.5 ppm (±2 ns) Accuracy**

**Delay Interval CRT Display**

The 7D11 Digital Delay plug-in gives stable delayed triggers for measurements requiring low jitter. The 7D11 also provides precision time delays. The 7D11 may be used in any compartment of a 7000 Series mainframe equipped with CRT readout. It provides a variety of outputs.

In the delay-by-events mode, the 7D11 counts arbitrary trigger events, periodic or aperiodic, and delivers an output after the preselected count has been reached (see Figure 2).

The delay-by-events mode is used to eliminate jitter in mechanically based systems such as disc file memories. It is also useful for selecting a certain time frame in data for analysis and for making other measurements under complex timing conditions.

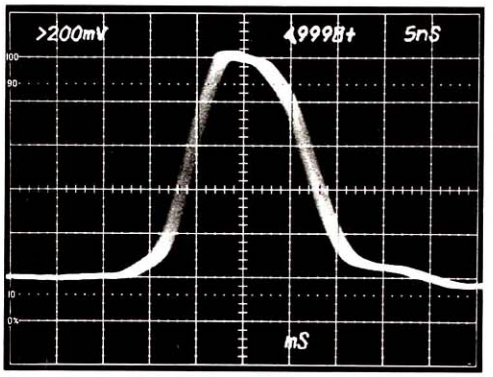



*Figure 1. Delay-by-time. A 0.2 μs time marker delayed 4.9998 ms by the 7D11 and displayed at 5 ns/div.*

An accurate and jitter-free delay-by-time is very useful when working with digital logic, pcm telemetry, sonar, radar, shock tube testing, and delay line measurements, to name a few. On receipt of a trigger, the 7D11 in the delay-by-time mode counts a highly accurate clock; at the selected delay time, it delivers a delayed trigger to its front-panel connector and mainframe. In both modes, delay time or number of events to be counted is selected by a single front-panel control.

When the 7D11 is installed in a vertical compartment, the CRT can display a waveform that lasts for the duration of the delay interval. This waveform may be displayed together with the signal waveform the 7D11 triggers on. From a vertical compartment, the 7D11 can trigger a time base such as 7B80, 7B53A, or another 7D11 through the internal mainframe trigger path.

In any horizontal compartment, the 7D11 generates a display similar to the "A intensified by B" mode of conventional delayed sweep (see Figure 2). When used in the A horizontal compartment, the 7D11 B sweep delay mode controls will permit the B sweep to run after the delay generated by the 7D11. This delay interval is also available at the front panel for such uses as gated interval counter measurements and generating pulses of highly accurate width.

In delay-by-events, an external pulse (events start trigger) may be used to enable counting of the events. In such applications as a line selector on a video monitor, the vertical sync pulse is the events start trigger. Then the 7D11 counts "n" number of horizontal sync pulses (events) into the field or frame. In a similar manner, the origin pulse of a disc memory can be used as the events start trigger, and the disc clock pulses become the events that are counted.

For timing measurements that require a higher degree of accuracy than the 0.5 ppm source available in the 7D11, the delay-by-time clock may be referenced to an external 1 MHz timing standard through the Ext 1 MHz input.

Time delay resolution up to 1 ns may be obtained by using the front-panel fine delay control.

By setting an internal switch, the indicated delay time is half the actual delay time. In such applications as TDR, radar timing, etc, the CRT readout would display the "one-way-trip" time.

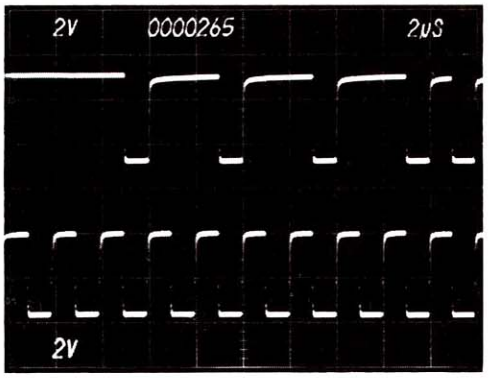



*Figure 2. Delay-by events. The lower trace is the master clock in our logic circuit. The top trace is our data which is delayed by 265 clock pulses.*

## CHARACTERISTICS

### EVENTS DELAY

**Events Delay Range** — One to $10^7$ events.
**Delay Increment** — One event.
**Insertion Delay** — 35 ns ±5 ns.
**Recycle Time** — <500 ns.
**Maximum Event Frequency** — At least 50 MHz.

### TRIGGERING

**External Trigger**

| | |
|---|---|
| Source | Int, Line, Ext, Ext ÷ 10 |
| Coupling | Dc, Ac, Ac LF Rej, Ac HF Rej |
| Max Input Voltage | 250 V Dc + peak Ac |
| Level Range | ±1.75 V in Ext<br>±17.5 V in Ext ÷ 10 |
| Input R and C | 1 MΩ ±5%, 20 pF ±2 pF |

**Triggering Sensitivity**

| Coupling | Frequency Range | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|---|
| Ac | 30 kHz to 10 MHz<br>10 MHz to 50 MHz | 0.3 div<br>1.0 div | 150 mV<br>750 mV |
| Ac LF Rej*1 | 30 kHz to 10 MHz<br>150 kHz to 10 MHz<br>10 MHz to 50 MHz | 0.3 div<br>——<br>1.0 div | ——<br>150 mV<br>750 mV |
| Ac HF Rej | 30 Hz to 50 kHz | 0.3 div | 150 mV |
| Dc | Dc to 10 MHz<br>10 MHz to 50 MHz | 0.3 div<br>1.0 div | 150 mV<br>750 mV |

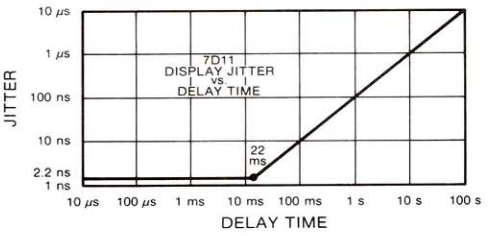
**1 Will not trigger on sine waves of three division or less Int or 1.5 V Ext below 120 Hz.*

**Events Start Trigger**

| | |
|---|---|
| Source | External Only |
| Coupling | Dc Only |
| Max Input Voltage | 150 V dc + peak ac |
| Level Range | ±3 V |
| Input R & C | 1 MΩ within 5%, 20 pF ±2 pF |
| Sensitivity | 100 mV min, 30 Hz to 2 MHz;<br>increasing to 250 mV, 2 MHz to 20 MHz;<br>increasing to 500 mV, 20 MHz to 50 MHz. |

### TIME DELAY

**Digital Delay Range** — Normal Mode: 100 ns to 1 s in 100 ns increments. Echo Mode: 200 ns to 2 s in 200 ns increments.
**Analog Delay** — Continuously variable from 0 ns to at least 100 ns, accuracy within 2 ns of indicated delay.
**Jitter With Internal Clock** — 2.2 ns or delay time x $10^{-7}$, whichever is greater.




**Insertion Delay** — Zero within 2 ns.
**Recycle Time** — Less than 575 ns.
**Time Base** — 500 MHz oscillator phase-locked to internal or external clock.
**Clock** — Internal: 5 MHz crystal oscillator. Accuracy is 0.5 ppm. External: 1 MHz within 1%, ac coupled, 50 Ω.

### OUTPUTS

**Delayed Trigger Out** — Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω. Risetime into 50 Ω Load: 2 ns or less. Falltime into 50 Ω Load: 5 ns or less. Pulse Width: 200 ns to 250 ns.
**Delay Interval Out** — Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω. Risetime Into Falltime: 5 ns or less. Accuracy: Equal to delay interval less 20 ns to 30 ns.

### READOUT

**Display** — 7½ digit with leading zero suppression, ms legend in time delay mode. Plus (+) symbol reminds the operator to add on the Fine Delay (ns) setting.
**Included Accessory** — Instruction manual.

## ORDERING INFORMATION

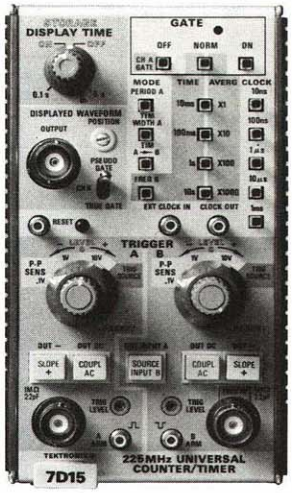
**7D11** Digital Delay Unit ..... **$3,185**





For recommended probes refer to pages 230 and 440.

7D15




225 MHz Counter/Timer

# 7D15

**Oscilloscope-Controlled Time and Frequency Measurements**

**10 ns Single-Shot Time Interval Measurement Resolution**

**Time Interval Averaging**

**CRT Display of Counting Interval**

**10 ps Period-Averaging Resolution**

**Frequency Measurements Directly to 225 MHz**

**Signal Conditioning via Mainframe Trigger Source**

The 7D15 Universal Counter/Timer is designed for use in all 7000 Series oscilloscope mainframes with CRT readout.

The 7D15 can be completely controlled by the oscilloscope's delayed gate. Arming inputs are provided for each channel. By using the delayed B gate to control the start and stop count points, visually selective measurements can be made at any point on the CRT display.

The 7D15 offers all the measurement capabilities of a Universal Counter/Timer, such as time interval, period, period and time interval averaging, frequency, frequency ratio, totalize, and manual stop watch.

The 7D15 may be used in vertical or horizontal compartments of 7000 Series mainframes. It provides a full eight-digit CRT display with leading zero suppression and positioned decimal. Legend and averaging information appear at the bottom of the CRT display.

**Order 42W-5017-1 for detailed 7D15 Measurement Applications Guide.**

## Modes of Operation

| | | |
|---|---|---|
| Frequency Mode | Range | Dc to 225 MHz<br>Resolution 0.1 Hz max |
| | Accuracy | $\epsilon_{Freq(Hz)} = \pm TB \bullet f_{in} \pm \frac{1}{T}$ |
| Period and Multi-Period Mode | Range | 10 ns to $10^5$ seconds with selected averaging of 1 to 1000 events in decade steps.<br>Resolution to 10 picoseconds. |
| | Accuracy | $\epsilon_{Period(s)} = \pm TB \bullet P_{in} \pm \frac{10^{-9}}{M} \pm \frac{2E_{npk}}{\frac{dv}{dt}} \bullet M \pm \frac{P_{ck}}{M}$ |
| Time Interval (TI) and TI Average Mode | Range | 6 ns to 10 seconds with selected averaging of 1 to 1000 in decade steps.<br>Resolution is 0.1 ns. |
| | Accuracy Worst Case (Nominal) | $\epsilon_{TI(s)} = \pm TB \bullet P_{in} \pm \frac{P_{ck}}{\sqrt{M}} \pm 10^{-9} \pm \frac{2E_{npk}}{\frac{dv}{dt}}$ |
| Frequency Ratio, CH B/Ext Clock | Range | $10^{-7}$ to $10^4$ |
| Manual Stop Watch | Range | 0 to $10^5$ seconds |
| Totalize, CH B | Range | 0 to $10^8$ counts |

*Note: Formulas given where $\epsilon$ is the error; TB (expressed as a decimal) is the time base accuracy; $P_{in}$ is the period of time interval of unknown signal; M is the number of averages given; $P_{ck}$ is the measurement clock period; T is the gate time; $f_{in}$ is the frequency of the unknown signal; $E_{npk}$ equals peak noise pulse amplitude as presented to Schmitt trigger circuit; dv/dt equals signal slope at input to Schmitt trigger (volts per second).*

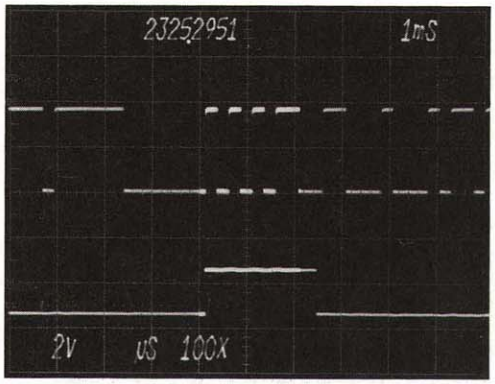



*Figure 1. Oscilloscope-controlled digital measurements using the delayed B gate as the arming input logic allow user to make precise time interval measurement from third to seventh pulse on CRT display. Counter CH A is "armed" with leading edge of B gate while CH B Counter is "armed" with falling edge of B gate. Lower trace is pseudo gate of 7D15. CRT readout displays the result of 2325.295 μs.*

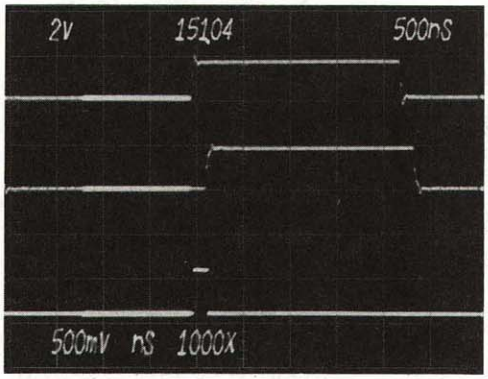



*Figure 2. The propagation delay time between the input of a delay line (upper trace) and the output of the delay line (middle trace) is measured digitally. Lower trace is 7D15 pseudo gate display. CRT readout displays the result of 151.0 ns.*

## CHARACTERISTICS

### INPUT SIGNAL CH A & B

**Frequency Range (CH B Only)** — Dc Coupled: Dc to 225 MHz. Ac Coupled: 5 Hz to 225 MHz.

**Sensitivity (CH A and B Inputs)** — 100 mV p-p. Trigger Source: 0.5 division to 100 MHz, 1.0 division to 225 MHz, or to the vertical system bandwidth, whichever is less.

**Input R and C** — 1 MΩ and 22 pF.

**Triggering (Preset Position)** — Automatically triggers at 0 V.

**Level Control Range (CH A and B Inputs)** — 100 mV Range: ±500 mV. 1 V Range: ±5 V. 10 V Range: ±50 V.

**Arming Inputs** — Input R and C: 10 kΩ and 20 pF. Sensitivity Arm A: Logical 1 ≥ +0.5 V, logical 0 ≤ +0.2 V. Sensitivity Arm B: Logical 1 ≤ +0.2 V, logical 0 ≥ +0.5 V.

**External Clock-In** — 20 Hz to 5 MHz.

**Reset Front Panel** — Reset readies the instrument. All counters are affected, including averaging circuits.

### INTERNAL TIME BASE

**Crystal Oscillator** — Accuracy: Within 0.5 ppm (0°C to +50°C ambient). Long-Term Drift: 1 part or less in $10^7$ per month. Oscillator: Temperature compensated; no warm up is required.

### OUTPUT SIGNALS

**Clock Out** — Logical 1 ≥ +0.5 V into 50 Ω. Logical 0 ≤0 V into 50 Ω. TTL compatible without 50 Ω load (1.6 mA current capacity).

**A and B Trigger Level** — $Z_{out} \approx 1$ kΩ, $V_{out} = \pm 0.5$ V into 1 MΩ.

**Displayed Waveform (Internally Connected)** — Front-panel switch selects true gate, pseudo gate, or CH B signal out. Position controlled by front-panel screwdriver control.

**External Display** — Same as internal except position control has no effect.

**Display Mode Switch** — 0.1 s to 5 s; also a preset position for infinite display time. Allows selection of readout "follow or store."

**Readout** — Eight-digit display; the four most significant have zero suppression. Overflow indicated by a greater than symbol.

### INCLUDED ACCESSORIES

Two 44 inch Sealectro to BNC connector cables (012-0403-00); instruction manual.

## ORDERING INFORMATION

**7D15** Universal Counter/Timer ..... **$3,300**

For recommended probes refer to pages 230 and 440.

## 7D12/M2

**Oscilloscope-Controlled Sampling DVM**

**≤10 ns Aperture Uncertainty**

**Input Signal and Sample Points Displayed on CRT**

**1 mV Resolution**

**25 MHz Bandwidth**

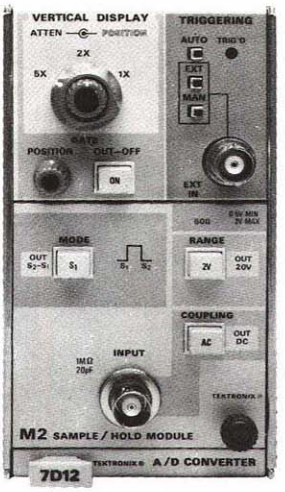
**0 V to 2 V and 0 V to 20 V Input Range, 200 V with P6055 Probe**

**Automatic, Manual, or External Triggering**

**Automatic Polarity and Overrange Indicators**

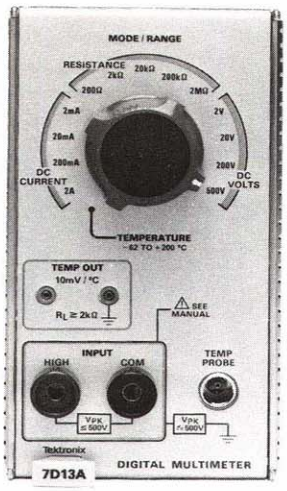
**3 1/2 Digit CRT Readout**

7D12/M2




**A/D Converter and Sample/Hold Module**

7D13A




**Digital Multimeter**

The 7D12 is designed for use with all 7000 Series oscilloscope mainframes with CRT readout.

The M2 Sample/Hold Module measures voltage amplitude from ground to a selected point or the difference voltage between any two selected points (independent control of each point). The sample point(s) may be triggered automatically, manually, or externally from sources such as the oscilloscope's Delayed B gate, the 7D15's pseudo gate, 7D11's delayed trigger out, etc.

On command, the 7D12/M2 samples the displayed waveform and also generates a gate display. Both the signal and 7D12/M2 gate are displayed together, providing a visual indication of where the sample(s) is taken. In the S mode (sample one), a single sample coincident with the rise of the 7D12/M2 displayed gate is taken, and the voltage amplitude, from the 0 V level, is digitally displayed on the CRT readout. In the $S_2$ - $S_1$ mode (sample two minus sample one), two samples are taken, one at the rise and one at the fall of the 7D12/M2 displayed gate, and the voltage difference between these two points is digitally displayed on the CRT readout.

### CHARACTERISTICS

**Sample-Gate Display Amplitude** — Two division, risetime and falltime 5 ns or less.

**Analog-Signal Display** — Bandwidth is dc to 25 MHz (dc coupling), 3.4 Hz to 25 MHz (ac coupling). Vertical Sensitivity is 100 mV/div to 5 V/div in 6 steps (1-2-5 sequence in combination with M2 range and 7D12 vertical display attenuation). Accuracy is within 5%.

**Input R and C** — 1 MΩ and 20 pF.

**Maximum Input Voltage** — 100 V peak.

**Measurement Readout** — 0 V to 20 V in two ranges. 3 1/2-digit presentation of 1.999 V and 19.99 V full scale, extended to 199.9 V with P6055 Probe.

**Overrange Indication** — When overrange occurs, a > symbol appears to the left of the reading.

**Aperture Uncertainty** — 10 ns or less.

**Pulse-Width Sample Time ($S_2$ − $S_1$ Mode)** — 30 ns to 5 ms with repetitive signal. 150 μs to 5 ms with single-shot signal.

**Measurement Rate** — External Trigger: 1 to 12 measurements per second, depending on external trigger frequency and internal adjustment. Auto Trigger: 1 to 4 measurements per second, internally adjustable.

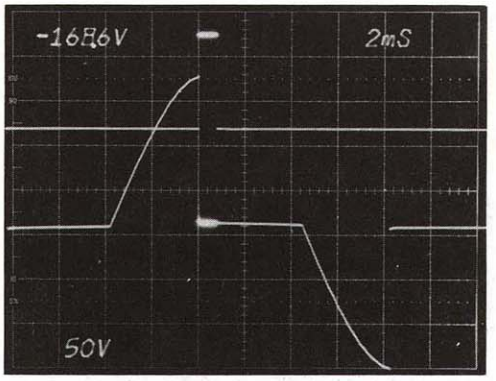
**Settling Time** — 40 ns.

**Accuracy Without Probe*1**

| Temperature Range | $S_1$ Mode | $S_2$ − $S_1$ Mode |
|---|---|---|
| +20°C to +30°C | ±0.15% of p-p input voltage, ±0.1% of reading, ±2 counts, ± the percentage of ac decay*2 | ±0.25% of p-p input voltage, ±0.15% of reading, ±2 counts, ± the percentage of ac decay*2 |
| +15°C to +40°C | ±0.25% of p-p input voltage, ±0.2% of reading, ±3 counts, ± the percentage of ac decay*2 | ±0.35% of p-p input voltage, ±0.25% of reading, ±3 counts, ± the percentage of ac decay*2 |

*1 *40 ns after Input Signal Step Function.*

*2 *Applicable when M2 is ac coupled.*




*Sample and Hold DVM measures difference voltage (−168.6 V) between two points on complex waveform. Gate waveform indicates two points: leading and trailing edges where voltage difference is made.*

**INCLUDED ACCESSORIES**

3.5 ft P6055 probe package (010-6055-01); instruction manual.

### ORDERING INFORMATION

**7D12** A/D Converter (Module Not Included) ..... **$1,675**

**M2** Sample/Hold Module ..... **$1,470**

**Option 02 — Without P6055** ..... **−$120**

## 7D13A

**Temperature Mode**

**500 V Maximum Common-Mode Voltage**

**3 1/2 Digit CRT Readout**

The 7D13A Digital Multimeter is designed for use in all 7000 Series oscilloscope mainframes with CRT readout. The 7D13A functions in any compartment.

The 7D13A measures dc volts, dc current, and resistance. It also measures temperature from a temperature sensor on the tip of the P6601 temperature probe. The temperature probe functions regardless of 7D13A mode or range setting and provides a front-panel analog signal output of 10 mV/°C (0°C = 0 V). Temperature may be measured simultaneously along with any other function.

When the 7D13A is used, the character generator traces out a 3 1/2-digit display on the CRT and a legend for units like kΩ, mA, °C.

### CHARACTERISTICS

**Dc Voltage Range** — 0 V to 500 V in four ranges. 3 1/2-digit presentation of 1.999 V, 19.99 V, 199.9 V, and 500 V full scale. Accuracy is ±0.1% of reading ±1 count from +15°C to +35°C, ±0.2% of reading ±2 counts from 0°C to +50°C. Input impedance is 10 MΩ on all ranges. Maximum safe input is 500 V peak between either contact and ground, 500 V peak between voltage contacts.

**Dc Current Range** — 0 A to 2 A in four ranges. 3 1/2-digit presentation of 1.999 mA, 19.99 mA, 199.9 mA, and 1999 mA full scale. Accuracy is ±0.5% of reading ±2 counts from +15°C to +35°C, ±0.7% of reading ±4 counts from 0°C to +50°C. Maximum input is 3 A (fuse protected).

**Resistance Range** — 0 MΩ to 2 MΩ in five ranges. 3 1/2-digit presentation 199.9 Ω, 1999 Ω, 19.99 kΩ, 199.9 kΩ, and 1999 kΩ full scale. Accuracy is ±0.5% of reading ±1 count from +15°C to +35°C, ±0.8% of reading ±2 counts from 0°C to +50°C. Input is fuse protected.

**Temperature Measurement Range** — −62°C to +200°C in one range. 3 1/2-digit presentation to +200°C.

**Temperature Measurement Accuracy*1**

| 7D13A Operating Conditions | Temperature Value Measured | Measurement Accuracy |
|---|---|---|
| +18°C to +28°C (room temperature) | −62°C to +150°C | ±2°C |
| | +150°C to +200°C | 0°C, −6°C |
| 0°C to +18°C +28°C to +50°C | −62°C to +200°C | Add 1.5°C to above tolerance in each direction |

*1 *Probe calibrated to the instrument.*

**Settling Time** — 1 s or less (voltage, current, and resistance modes).

**Polarity** — Automatic indication.

**Maximum Common-Mode Voltage** — 500 V peak between two terminals and ground.

**Normal-Mode Rejection Ratio** — At least 30 dB at 60 Hz.

**Common-Mode Rejection Ratio** — With a 1 kΩ imbalance, at least 100 dB at dc; 80 dB at 60 Hz.

**Over Range Indication** — When over range occurs, the readout blinks and the most significant digit displays a three.

**Temperature Out** — 10 mV/°C into a load of at least 2 kΩ.

**INCLUDED ACCESSORIES**

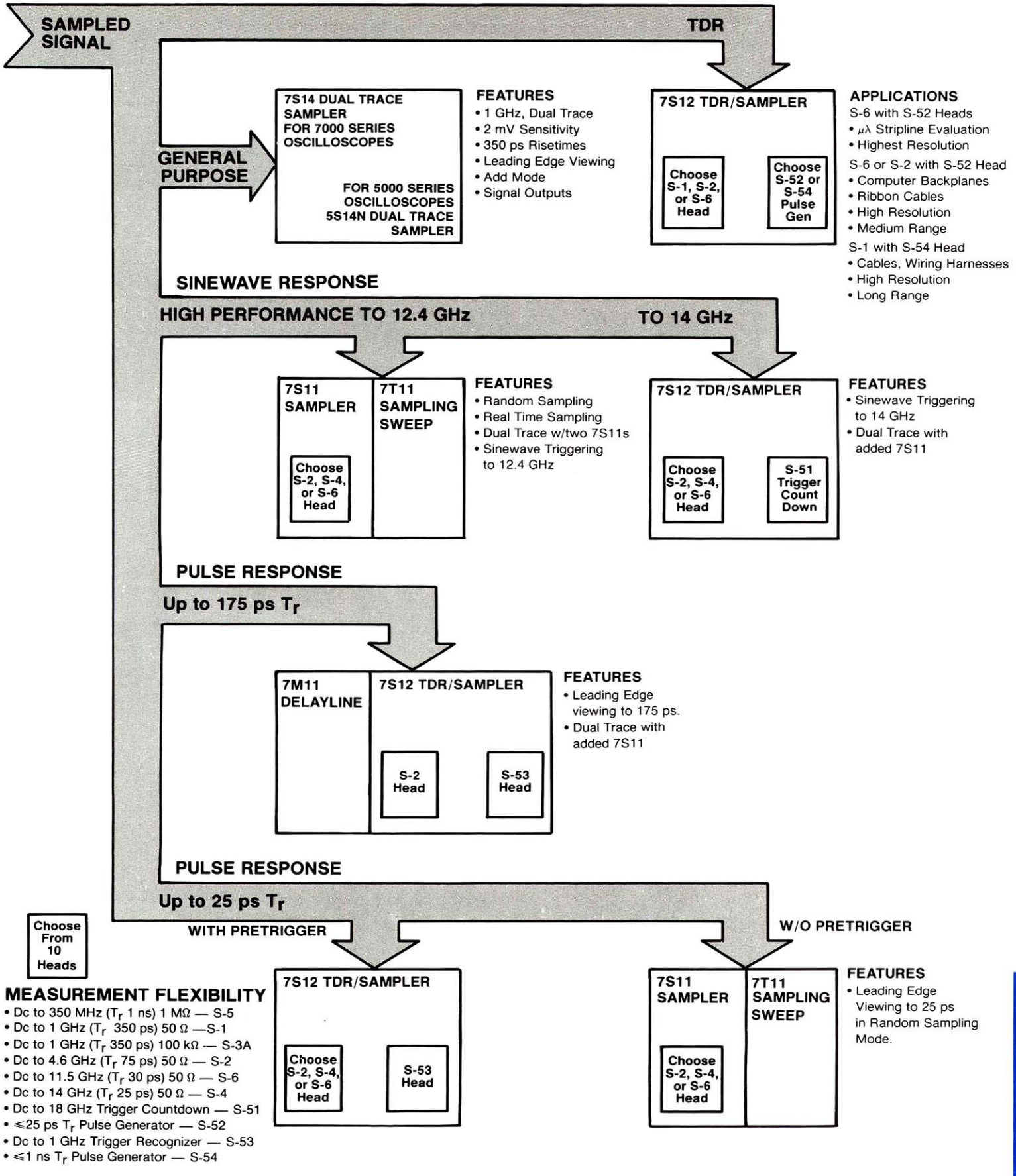
P6601 Temperature Probe package (010-6601-01); pair of test leads (003-0120-00); instruction manual.

### ORDERING INFORMATION

**7D13A** Digital Multimeter ..... **$1,210**

For recommended probes refer to pages 230 and 440.

# SAMPLING DECISION TREE FOR REPETITIVE SIGNALS



## Sampling Plug-ins

7000 Series sampling plug-ins can increase the versatility of your mainframe by providing measurement capabilities up to 14 GHz on repetitive signals. The Sampling family consists of five plug-ins, ten specially-designed sampling heads, and various supporting accessories that provide maximum configurability for the user.

Specific uses for samplers include general UHF measurement and TDR (Time Domain Reflectometry) although other applications are numerous.

For UHF requirements, Tektronix offers flexibility in time domain measurement. For example, the 7S11 Sampling Unit/7T11 Sampling Sweep combination provides triggering to 12.4 GHz, and the choice of modular heads for optimum signal acquisition. Two 7S11s and one 7T11 provide dual-trace capability. For users who want a plug-in sampler operationally similar to conventional vertical/time base plug-ins, the 1 GHz 7S14 is available. Two identical channels provide 2 mV/div sensitivity, dual trace display, built-in time base, and calibrated delayed sweep. All of these plug-ins provide a cost-effective way to obtain Gigahertz measurement capability for repetitive signals.

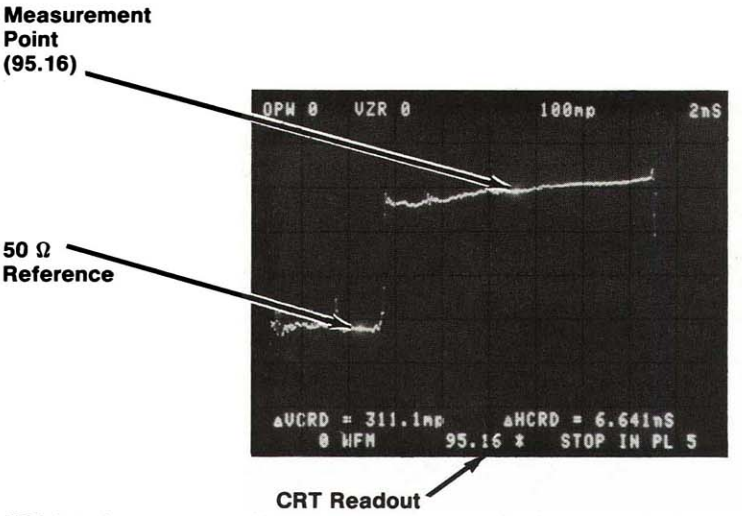
TDR is widely used in microwave stripline evaluation, computer backplane measurements, and printed circuit board testing. The fast risetimes of samplers make them well suited for these measurements. With TDR, a pulse is sent down a conductive path and measured as it reflects back from any impedance changes in the device under test. Any impedance variations in the path cause a corresponding signal to be displayed on the scope. The precise location and type of impedance anomaly (open, short, step change) in the conductive path is directly readable on the display. The 7S12 TDR Sampler is a high-resolution unit that provides maximum versatility for TDR measurements in addition to general purpose applications.

The Sampling Decision Tree diagram on page 265 can be helpful to select a configuration for a particular measurement requirement.

**SAMPLING HEAD CHARACTERISTICS**

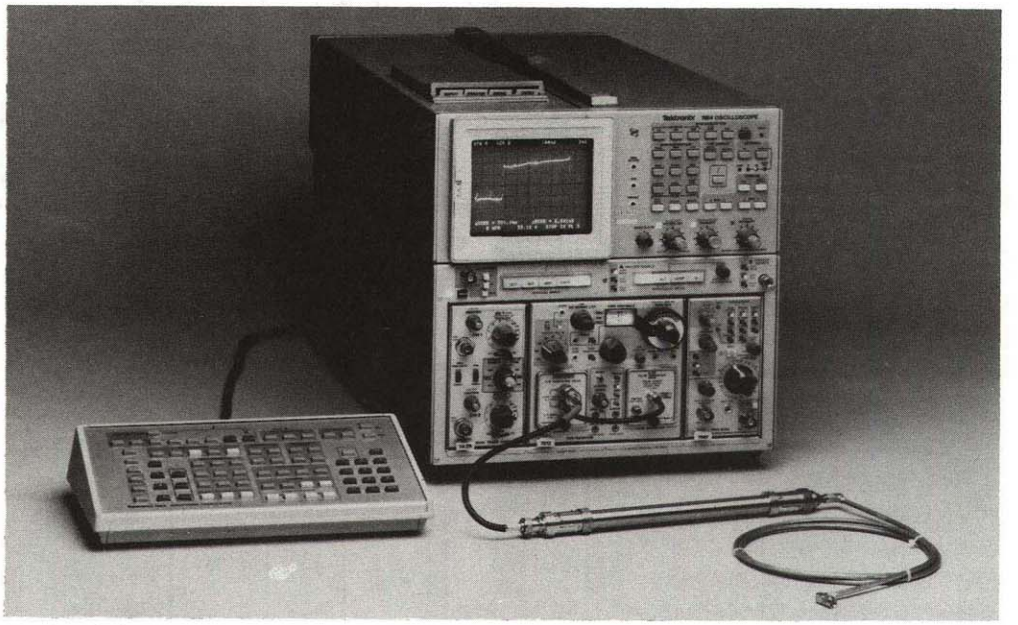
| | Bandwidth | Risetime | Input Impedance | Noise | Connector |
|---|---|---|---|---|---|
| S-1 | Dc to 1 GHz | ≤350 ps | 50 Ω | ≤1 mV*1<br>≤2 mV*2 | GR |
| S-2 | Dc to 4.6 GHz | ≤75 ps | 50 Ω | ≤3 mV*1<br>≤6 mV*2 | GR |
| S-3A | Dc to 1 GHz | ≤350 ps | 100 kΩ | —<br>≤3 mV at probe tip*2 | Probe |
| S-4 | Dc to 14 GHz | ≤25 ps | 50 Ω | ≤2.5mV*1<br>≤5 mV*2 | SMA (3 mm) |
| S-5 | Dc to 350 MHz | ≤1 ns | 1 MΩ | ≤500 μV*1<br>≤5 mV*2 | BNC |
| S-6 | Dc to 11.5 GHz | ≤30 ps | 50 Ω feed thru | —<br>≤5 mV*2 | SMA (3 mm) (3 mm) |

*1 Smoothed
*2 Unsmoothed




*CRT photo shows an automated impedance measurement on a four foot length of 93 Ohm coax. An easy-to-use program allows the operator to obtain a direct readout in Ohms (bottom center) after positioning cursors on selected points on the display.*

### Automated Measurements with the 7854 Oscilloscope and 7S12 Sampler Plug-in



*The 7854/7S12 combination is ideally suited for making a wide variety of automated sampling measurements. Examples of easy-to-program measurements are: measuring propagation delay through active or passive devices; measuring distance to faults in coax cables; and measuring impedance in EC boards and other controlled-impedance devices. Programs can be entered into the 7854 via the calculator keyboard for simple operator-controlled measurements, or tests can be computer-controlled via a remote terminal on the GPIB for production applications.*

**ACCESSORY PROBES FOR 50 Ω SAMPLERS**

| Type | Attenuation | Length*1 | Loading | | Risetime (in ns) | Bandwidth | Package Number*2 |
|---|---|---|---|---|---|---|---|
| **Passive** | | | | | | | |
| P6056 | 10X | 6.0 | 500 Ω | 1 pF | <0.1 | Dc to 3.5 GHz | 010-6056-03 |
| P6057 | 100X | 6.0 | 5 kΩ | 1 pF | <0.25 | Dc to 1.4 GHz | 010-6057-03 |
| **Active — FET*3** | | | | | | | |
| P6201 | 1X | 6.0 | 100 kΩ | 3 pF | <0.4 | Dc to 900 MHz | 010-6201-01 (includes attenuators) |
| | 10X | 6.0 | 1 MΩ | 1.5 pF | <0.4 | Dc to 900 MHz | |
| | 100X | 6.0 | 1 MΩ | 1.5 pF | <0.4 | Dc to 900 MHz | |
| P6202A | 10X | 2 M | 10 MΩ | 2 pF | <0.7 | Dc to 500 MHz | 010-6202-03 plus 010-0384-00 to provide 100X |
| | 100X | 2 M | 10 MΩ | 2 pF | <0.7 | Dc to 500 MHz | |
| **Active — Variable Bias/Offset*3** | | | | | | | |
| P6230 | 10X | 1.6 | 450 Ω | 1.6 pF | ≤0.23 ps | Dc to 1.5 GHz | 010-6230-01 |

*1 Length in feet except where specified.
*2 Refer to probe section for additional information.
*3 Requires power source: Most four compartment mainframes provide probe power. See page 436 for Probe Power Supplies.

# 7S12

**45 ps TDR or a General Purpose Sampler**

**6 Plug-In Sampling Heads Available**

**2 Plug-In Pulse Sources Available**

**1 Trigger Recognizer Head Available**

**1 Trigger Countdown Head Available**

The 7S12 is a combined vertical-horizontal, double-width plug-in for high resolution TDR or general purpose sampling measurements. As a TDR using the S-6 Sampling Head and S-52 Pulse Generator Head, the 7S12 has a system risetime of 45 ps (return from short-circuit termination) and distance range to 250 feet in any cable. Its vertical scale is calibrated in reflection coefficient ($\rho$) from 2 m$\rho$/div to 500 m$\rho$/div and in voltage from 2 mV/div to 500 mV/div. Two-way time or one-way distance to a discontinuity of interest is read directly from tape dial calibrated for time, air, polyethylene, or your choice of dielectrics. As a long line TDR using the S-5 Sampling Head and S-54 Pulse Generator Head, distance calibration extends to 4900 feet (air line) and discontinuities to twice this distance may be viewed. System risetime with this combination is 1.5 ns.

General-purpose measurements may be made by using an S-1, S-2, S-3A, S-4, S-5, or S-6 Sampling Head with an S-53 Trigger Recognizer Head or S-51 Trigger Countdown Head. For dual-trace sampling displays, use a 7S11 Sampling Unit with a 7S12. The addition of a 7M11 Dual Delay Line provides the signal delay necessary to view the triggering event when a pretrigger signal is not available.

## CHARACTERISTICS

### SYSTEM PERFORMANCE WITH S-6 AND S-52

**System Risetime** — 35 ps or less for the incident step. 45 ps or less for the displayed reflection from a short-circuited, 1 ns test line.

**Time and Distance Ranges** — Direct-reading tape dial gives calibrated one-way distance to at least 375 ft (air line). Time range is at least 0.75 $\mu$s round trip. Both ranges are limited by the duration of the pulse from the S-52.

**Pulse Amplitude** — At least +200 mV into 50 Ω.

**Input Characteristics** — Nominal 50 Ω, feed-through signal channel (termination supplied). SMA (3 mm) connectors.

**Jitter** — <10 ps (without signal averaging).

**Aberrations** — +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

### TDR SYSTEM PERFORMANCE WITH S-5 AND S-54

**System Risetime** — 1.5 ns or less for the displayed reflection from a short-circuited test line.

**Time and Distance Ranges** — Direct-reading tape dial gives calibrated one-way distances to 4900 ft (air line), 3240 ft solid polyethylene. Time range is 20 $\mu$s round trip.

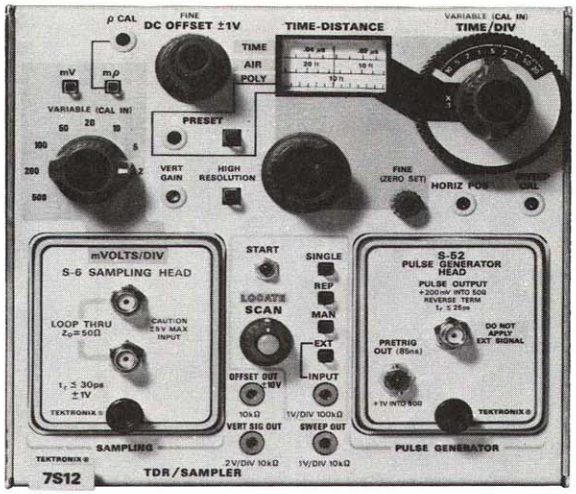
**Pulse Amplitude** — At least +400 mV into 50 Ω.

**Input Characteristics** — Nominal 50 Ω test line connection (cable and T supplied). BNC connectors.

**Jitter** — <20 ps (without signal averaging).

**Aberrations** — +4%, −6%, total of 10% p-p within first 17 ns of step; +1.5%, −1.5%, total of 3% thereafter.

**7S12**




**TDR/Sampler**

### OTHER 7S12 CHARACTERISTICS

**Vertical Scale** — Calibrated in m$\rho$ (reflection coefficient $10^{-3}$) and mV from 2 to 500 units/div in 8 steps (1-2-5 sequence), accurate within 3%. Uncalibrated variable is continuous between steps.

**Resolution** — Reflection coefficients as low as 0.001 may be observed. Signal averaging reduces test-line noise in display.

**Dc Offset Range** — +1 V to −1 V. Allows open-circuit reflections to be displayed at full sensitivity. Monitor jack provides X10 dc offset through 10 kΩ.

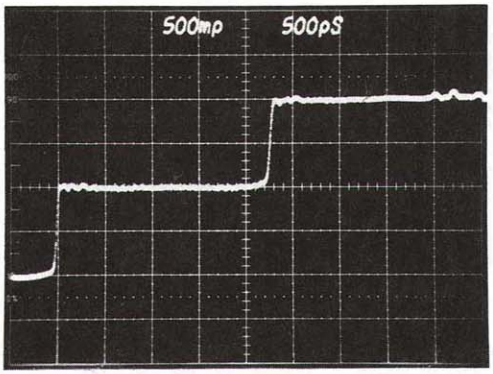
**Time/Distance** — Tape Dial is Calibrated in Time and Distance: Full-scale ranges of 4900 ft, 490 ft, 49 ft (air dielectric); 3200 ft, 320 ft, 32 ft (polyethylene dielectric); and 10 $\mu$s, 1 $\mu$s, 0.1 $\mu$s (time). Accurate within 1%. Distance calibration may be preset for dielectric having propagation factors from 0.6 to 1.

**Time/Div** — 20 ps/div to 1 $\mu$s/div (1-2-5 sequence) in three ranges with direct-reading magnifier. Accurate within 3%. Uncalibrated variable is continuous between steps.

**Locate Button** — Provides instant return to unmagnified display showing entire full-scale range. Brightened portion of trace indicates time position and duration of magnified display.

**Display Modes** — Repetitive or single sweep, manual or external scan.

**Signal Outputs** — Pin jacks provide both vertical signal and sweep outputs.




*The 7S12 displays reflection coefficient (ρ) versus distance on a device-under-test. Here the 7S12 measures a reflection caused by a crack (open) in a PCB under test. Distance can be read directly from the 7S12 front panel, or calculated from the time base settings.*

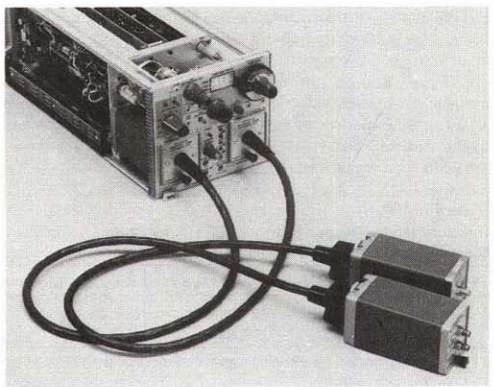
**For sampling heads — refer to pages 270 and 271.**

### INCLUDED ACCESSORIES

750 ps rigid "U" delay line (015-1017-01); short-circuit termination (015-1021-00); TDR slide rule (003-0700-00); TDR graticule overlay (331-0296-00); TDR graticule overlay (331-0297-00); instruction manual.

## ORDERING INFORMATION

**7S12** TDR/Sampler without Sampling Heads (Tape Dial in Feet) ..... **$3,780**
**Option 03** — Tape Dial Change (Meters) ..... **+$25**
**7603** Mainframe ..... **$2,955**



*Extenders allow the user to locate the sampling head directly in a test fixture, avoiding potential signal degradation by cables.*

### OPTIONAL ACCESSORIES

**3 ft Sampling-Head Extender** — Order 012-0124-00 .. **$415**
**6 ft Sampling-Head Extender** — Order 012-0125-00 .. **$490**

**NOTE: See 1502 and 1503 Portable TDR Cable Testers on pages 196-197.**

## 7T11

**10 ps/div to 5 ms/div Calibrated Time Base**

**Random or Sequential Sampling**

**Equivalent or Real Time Sampling**

**No Pretrigger Required**

The 7T11 Sampling Time Base provides equivalent-time and real-time horizontal deflection for single-trace or dual-trace sampling. Timing accuracy is within 3% and nonlinearity is well below 1%. Triggering range is from approximately 10 Hz (sequential mode) to above 12.4 GHz. The 7T11 works with all 7000 Series instruments and is a companion unit to the 7S11.

### CHARACTERISTICS

**Time/Div Range** — 10 ps/div to 5 ms/div (1-2-5 sequence) directly related to time position ranges. Uncalibrated variable is continuous between steps to at least 4 ps/div.

**Time Position Range** — Equivalent time is 50 ns to 50 μs in four steps; real time is 0.05 ms to 50 ms in three steps.

**Time/Div Accuracy** — Within 3% for all time/div settings over center 8 cm.

#### TRIGGERING

**Ext 50 Ω Input** — Frequency range is dc to 1 GHz in 1X Trig Amp mode. Sensitivity range is 12.5 mV to 2 V p-p (dc to 1 GHz) in X 1 Trig Amp, 1.25 mV to 2 V p-p (1 kHz to 50 MHz) in X10 Trig Amp. Input R is 50 Ω within 10%. Maximum input voltage is 2 V (dc + peak ac).

**Ext 1 MΩ Input** — Frequency range is dc to 100 MHz in X1 Trig Amp mode. Sensitivity range is 12.5 mV to 2 V p-p (dc to 100 MHz in X1 Trig Amp, 1.25 mV to 2 V p-p (1 kHz to 50 MHz) in X10 Trig Amp. Input R is 1 MΩ within 5%. Maximum input voltage is 100 V p-p to 1 kHz (derating 6 dB per octave to a minimum 5 V p-p).

**Ext HF Sync** — Frequency range is 1 GHz to 12.4 GHz. Sensitivity range is 10 mV to 500 mV p-p. Input R is 1 MΩ. Maximum input voltage is 2 V p-p.

**Int Trigger Source (Sinewave Triggering)*1** — Frequency range is 5 kHz to 500 MHz in X1 Trig Amp: 5 kHz to 50 MHz in X10 Trig Amp. Sensitivity range is 125 mV to 1 V p-p (referred to the vertical input) in X1 Trig Amp; 12.5 mV to 1 V p-p (referred to the vertical input) in the X10 Trig Amp.

**1 Trigger circuits will operate to dc with pulse triggering, except for HF Sync.*

**Random Mode Trigger Rate** — 100 Hz minimum.

**Display Jitter*1**

| Time Pos Range | Sequential Mode | Random Mode |
|---|---|---|
| 50 μs to 500 ns | 0.4 div or less | 1 div or less |
| 50 ns | 10 ps | 30 ps |

**1 Measured under optimum trigger conditions with Time/Div switch clockwise.*

**Pulse Out** — Positive pulse amplitude at least 400 mV (into 50 Ω) with 2.5 ns risetime or less.

**Trigger Kickout** — 2 mV or less into 50 Ω (except HF SYNC).

**Display Scan Rate** — Continuously selectable from at least 40 sweeps/s to <2 sweeps/s.

**External Scan** — Deflection factor is continuously variable from 1 V/div to 10 V/div. Input R is 100 kΩ with 10%. Maximum input voltage is 100 V (dc + peak ac).

**Sweep Out** — 1 V/div within 2%. Source R is 10 kΩ within 1%.

**Ambient Temperature** — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

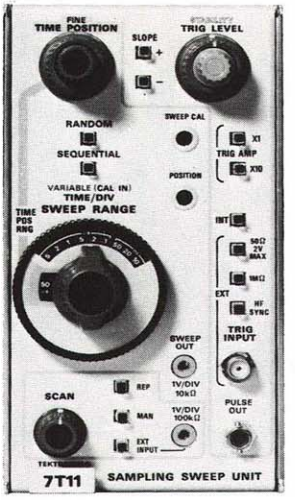
#### INCLUDED ACCESSORIES

42 inch BNC 50 Ω cable (012-0057-01); 3 mm SMA male to BNC adaptor (015-1018-00); 3 mm SMA male to GR874 adaptor (015-1007-00); 10X 50 Ω attenuator (011-0059-02); instruction manual.

### ORDERING INFORMATION

**7T11** Sampling Sweep Unit ..... **$4,975**

**7T11**

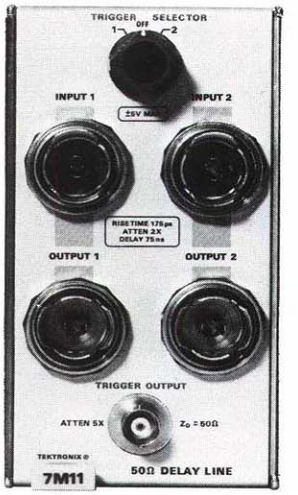



**Sampling Sweep Unit**

**7S11**

**Sampling Unit**

**7M11**




**Delay Line**

## 7S11

**2 mV/div to 200 mV/div Calibrated Deflection Factors**

**Plug-In Sampling Heads**

The 7S11 single-channel sampling unit employs the sampling plug-in head concept. The heads, which mount in the 7S11, range in bandwidth from 350 MHz to 14 GHz.

The 7S11 can be used in a variety of combinations. Single-channel sampling uses one 7S11 with a 7T11 Time Base. Two 7S11s and one 7T11 provide dual-trace sampling. One 7S11 and one 7S12 provide dual-trace sampling. Two 7S11s can be used for X-Y operations.

### CHARACTERISTICS

**Deflection Factor** — 2 mV/div to 200 mV/div in 7 steps (1-2-5 sequence), accurate within 3%. Uncalibrated variable is continuous (extends deflection factor from 1 mV/div or less to at least 400 mV/div). Deflection factor is determined by the plug-in sampling head.

**Bandwidth** — Determined by the sampling head.

**Input Impedance** — Determined by the sampling head.

**Dc Offset** — Range, +1 V to −1 V or more. Offset out is 10X the offset voltage within 2%. Source R is 10 kΩ within 1%.

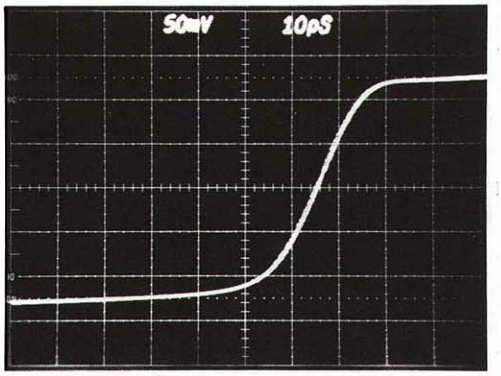
**Delay Range** — At least 10 ns for comparing two signals in a dual-trace application.

**Memory Slash** — 0.1 div or less at 20 Hz.

**Vertical Signal Out** — 200 mV per displayed div within 3%.

**Ambient Temperature** — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

**Included Accessory** — Instruction manual.




*7S11 and 7T11 Plug-ins together provide accurate measurements on repetitive signals. Pulse risetime of 21 ps shown.*

### ORDERING INFORMATION

**7S11** Sampling Unit without Sampling Head ..... **$1,985**

## 7M11

**75 ns Time Delay**

**Selectable Trigger out**

**175 ps Risetime**

The 7M11 is a passive dual delay line for use with the 7000 Series sampling system. In low-repetition-rate applications requiring the sequential mode of operation, the 7M11 provides the trigger source and signal delay necessary to view the triggering event at fast time-per-division settings.

Vertical delay for two 7S11 vertical sampling units is available with the dual 50 Ω, 75 ns delay lines. The closely matched (30 ps) lines have GR874 input-output connectors, 175 ps risetime, and 2X signal attenuation. Trigger selection is from either input, 5X attenuated, with a risetime of 600 ps or less.

### CHARACTERISTICS

#### DELAY LINE

**Time Delay** — 75 ns within 1 ns.

**Delay Difference** — 30 ps or less between channels.

**Risetime** — 175 ps or less.

**Attenuation** — 2X within 2% into 50 Ω.

**Input Impedance** — 50 Ω within 2%.

**Maximum Input** — ±5 V (dc + peak ac).

#### TRIGGER OUTPUT

**Risetime** — 600 ps or less.

**Attenuation** — 5X within 10% into 50 Ω (referred to input).

**Output Impedance** — 50 Ω within 10%.

**Ambient Temperature** — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

#### INCLUDED ACCESSORIES

Ten inch BNC cable (012-0208-00); two 2 ns GR cables (017-0505-00); instruction manual.

### ORDERING INFORMATION

**7M11** Delay Line ..... **$1,505**

**For sampling heads refer pages 270 and 271.**

# 7S14/5S14N

**Calibrated Delayed Sweep**

**Two-Dot Measurements**

**Dc to 1 GHz Bandwidth**

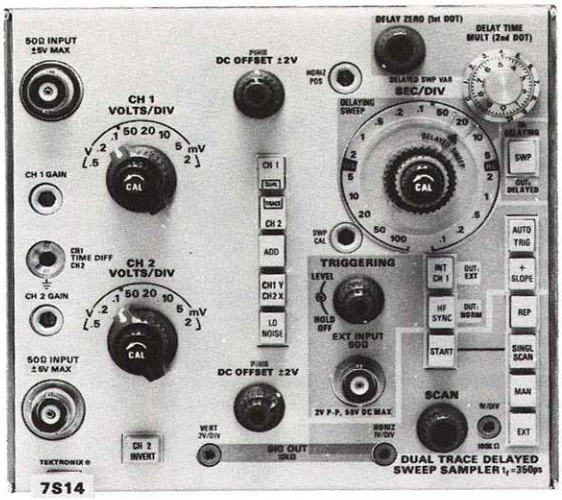
**Dual Trace, 2 mV Sensitivity**

**CRT Readout (7S14 Only)**

**Simplified Triggering**

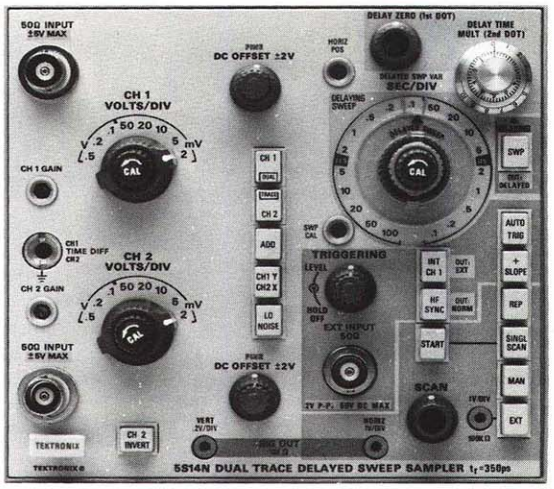
**Operational Ease of a Conventional Oscilloscope**

**7S14**




**Dual Trace Delayed Sweep Sampler**

**5S14N**




**Dual Trace Delayed Sweep Sampler**

The 7S14 Sampling Unit combines vertical and time-base functions in one double-width plug-in for 7000 Series oscilloscopes mainframes. Two identical vertical channels provide dual-trace sampling, a two-ramp time base and calibrated delayed sweep. Front-panel controls are grouped by color, and the control nomenclature is similar to conventional oscilloscope nomenclature. Learning to operate the 7S14 requires a minimum of effort for those familiar with conventional oscilloscope operation for 7000 Series.

A unique feature is a system for making two-dot time-interval measurements. This feature provides an easy and accurate means for measuring the time between two points on a waveform. One bright dot on the trace is positioned with the Delay Zero control to the start of an event to be measured. Next a second bright dot is positioned by the Delay Time Multiplier Control to the end of the event. The time-interval between the selected points is then determined by multiplying the number read directly from the Delay Time Multiplier Dial by the selected time per division.

The 5S14N Sampling Unit combines amplifier and time-base functions in one double-wide plug-in unit designed to operate in all 5000 Series mainframes. Combining the sampling amplifier and time-base functions in one plug-in enables the 5S14N to provide economy and ease of operation. There is no readout with the 5S14N.

## CHARACTERISTICS

The following specifications are identical for both units unless otherwise noted.

### VERTICAL CHANNEL

**Modes** — CH 1 only; CH 2 only; Dual Trace; CH 1 added to CH 2; CH 2 subtracted from CH 1 (CH 2 Invert); CH 1 Vertical (Y), CH 2 Horizontal (X).

**Input Impedance** — Nominally 50 Ω.

**Bandwidth** — Equivalent to dc to 1 GHz.

**Risetime** — 350 ps or less.

**Step Aberrations** — +2%, −3%, total of 5% p-p within first 5 ns, ±1% thereafter, both tested with a 284 Pulse Generator.

**Deflection Factor** — 2 mV/div to 0.5 V/div in 8 steps (1-2-5 sequence). Continuously variable between steps by at least 2.5 to 1.

**Accuracy** — Within ±3%.

**Maximum Input Voltage** — ±5 V.

**Input Signal Range** — 2 V p-p maximum within a +2 V to −2 V window at any sensitivity.

**Dc Offset Range** — At least +2 V to −2 V.

**Displayed Noise** — 2 mV or less unsmoothed (measured tangentially). Low noise pushbutton reduces random noise by a factor of 4 to 1 or more.

**Vertical Signal Output** — 0.2 V/div of vertical deflection; 10 kΩ source resistance.

**Channel Delay Difference** — Adjustable to zero, or for any time difference up to at least 1 ns.

### TIME BASE

**Scan Modes** — Repetitive, single, manual, or external.

**Delaying Sweep** — May be used as the CRT time base or as a delay generator for the delayed sweep. The sweep starts with minimum delay from the instant of trigger recognition. When the delaying sweep mode is selected for the time base, two bright dots in the trace, which may be positioned anywhere on the displayed waveform, are generated. The time between dots is equal to the reading on the Delay Time Multiplier dial multiplied by the Time/Div.

**Delayed Sweep** — This mode is used when the signal to be displayed occurs considerably later than the instant of trigger recognition or when the time must be 5 ns or less per division. The delayed sweep may be started with zero delay time with respect to the start of the delaying sweep. Or the start may be delayed by any time interval up to that represented by 10 divisions of the delaying sweep selected.

**Horizontal Signal Output** — 1.0 V/div of horizontal deflection; 10 kΩ source resistance.

### DELAYING SWEEP

**Range** — 10 ns/div to 100 μs/div in 13 steps (1-2-5 sequence).

**Accuracy** — Within ±3%, excluding first 0.5 division of displayed sweep.

**Delayed Zero (1st Dot)** — Adjustable to correspond to any instant within the time interval represented by the first 9 division of the delaying sweep selected.

**Delay Time (2nd Dot)** — Adjustable to any position of the time interval represented by 10 division of the delaying sweep selected.

**Delay Accuracy** — Within ±1% of 10 division when measurement is made within the last 9.5 division.

### DELAYED SWEEP

**Range** — 100 ps/div to 100 μs/div in 19 steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

**Accuracy** — Within ±3% excluding first 0.5 division of displayed sweep.

**Start Delay** — Depends on the delaying sweep time selected and the setting of the Delay Time Multiplier dial. Adjustable from zero to any time interval up to that represented by 10 divisions of the delaying sweep selected. The delaying sweep start point corresponds to the position of the second bright dot.

**Delay Jitter** — <0.05% of the time represented by 1 division of the delaying sweep selected.

### TRIGGERING AND SYNC

**Signal Sources** — Internal from CH 1 vertical input or external through front-panel connector.

**External Triggering** — Nominal 50 Ω input, ac coupled, 2 V p-p 50 V dc maximum. Trigger pulse amplitude 10 mV p-p or more with risetime of 1 μs or less. 10 Hz to 100 MHz. Sinewave amplitude 10 mV p-p or more from 150 kHz to 100 MHz.

**Internal Triggering** — Pulse amplitude 50 mV p-p or more with risetime of 1 μs or less. Sinewave amplitude 50 mV p-p or more from 150 kHz to 100 MHz.

**Triggered Mode** — Trigger recognition may be made to occur at any selected voltage level between +0.5 V and −0.5 V on either a + slope or a − slope of the triggering signal.

**Autotrigger Mode** — For small signals or when there may be no triggering signal. Sampling pulses are automatically generated at a low rate in the absence of a triggering signal so that a trace may always be generated and displayed. The trigger level range automatically adjusts to approximately the p-p voltage of the signal.

**Holdoff** — Varies the length of the interval during which recognition is inhibited. Variation is at least 5 to 1. The control is particularly useful for displaying digital words when triggering on binary pulses.

**HF SYNC Mode** — For sinewaves from 100 MHz to 1 GHz, 10 mV p-p or more from external source, 50 mV p-p or more from internal pickoff.

### INCLUDED ACCESSORIES

Two X10 attenuators (011-0059-02); two 42 in 50 Ω coaxial cables (012-0057-01); instruction manual.

## ORDERING INFORMATION

**7S14** Dual-Trace Delayed Sweep Sampler for 7000 Series Oscilloscopes ..... **$5,785**

**5S14N** Dual-Trace Delayed Sweep Sampler for 5000 Series Oscilloscopes ..... **$5,920**

## S-1

### Dc to 1 GHz Bandwidth

### Clean Transient Response

The S-1 Sampling Head is a low noise, 350 ps risetime unit with a 50 Ω input impedance. The S-1 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-1 provides a trigger signal output from the plug-in unit.
**Risetime** — 350 ps or less.
**Bandwidth** — Equivalent to dc to 1 GHz at 3 dB down.
**Transient Response** — Aberrations as observed with the 284 Pulse Generator are +0.5%, −3% or less, total of 3.5% or less p-p, first 5 ns following the step transition; −0.5% or less, total of 1% or less p-p after 5 ns.
**Displayed Noise** — 2 mV or less, unsmoothed; 1 mV, smoothed.
**Signal Range** — Variable dc offset allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. Signals between +2 V and −2 V limits may be displayed at 200 mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be <500 mV p-p.
**Input Characteristics** — Norminally 50 Ω. Safe overload in ±5 V. GR874 input connectors.
**Included Accessories** — 5 ns, 50 Ω RG58 A/U cable (017-0512-00); 10X, 50 Ω GR attenuator (017-0078-00); instruction manual.
**Weight** — Net: 0.5 kg (1.0 lb). Shipping: 1.4 kg (3.0 lb).

**ORDERING INFORMATION**

**S-1** Sampling Head ..... **$1,285**

## S-2

### Dc to 4.6 GHz Bandwidth

### Displayed Noise <6 mV (Unsmoothed)

The S-2 Sampling Head is a 75 ps risetime unit with a 50 Ω input impedance. The S-2 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-2 provides a trigger signal output from the plug-in unit.
**Risetime** — 75 ps or less.
**Bandwidth** — Equivalent to dc to 4.6 GHz at 3 dB down.
**Transient Response** — Aberrations as observed with the 284 Pulse Generator are +5%, −5% or less, total of 10% or less p-p, first 2.5 ns following a step transition; +2%, −2% or less total of 4% or less p-p after 2.5 ns.
**Displayed Noise** — 6 mV or less, unsmoothed; 3 mV, smoothed.
**Signal Range** — Variable dc offset allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. Signals between +2 V and −2 V limits may be displayed at 200 mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be <200 mV p-p.
**Input Characteristics** — Nominally 50 Ω. Safe overload is ±5 V. GR874 input connectors.
**Included Accessories** — 5 ns, 50 Ω RG213/U Cable (017-0502-00); 10X, 50 Ω GR attenuator (017-0078-00); instruction manual..
**Weight** — Net: 0.5 kg (1.0 lb). Shipping: 1.4 kg (3.0 lb).

**ORDERING INFORMATION**

**S-2** Sampling Head ..... **$1,505**

## S-3A

### Compact, 4.5 ft, 100 kΩ, 2.3 pF Probe

### Dc to 1 GHz Bandwidth

### Displayed Noise <3 mV (Unsmoothed)

The S-3A Sampling Head is an active sampling-probe unit with 100 kΩ, 2.3 pF input impedance. Up to 2 V of dc offset may be used while maintaining a 2 mV/div deflection factor.
**Risetime** — 350 ps or less.
**Bandwidth (Probe Only)** — Equivalent to dc to 1 GHz at 3 dB down.
**Transient Response (Probe Only)** — Aberrations in the first 2 ns following a step are +8%, −2% or less, total of 10% or less p-p, +1%, −1% or less, total of 2% or less p-p after 2 ns, with 284 pulse displayed.
**Displayed Noise (Probe Only)** — 3 mV or less referred to probe tip (includes 90% of dots).
**Signal Range** — Variable dc offset allows signals between +1 V, 1X range, or +2 V and −2 V, 2X range, to be displayed at 2 mV/div. The signal range may be increased 10X or 100X with the probe attenuators.
**Included Accessories** — 10X attenuator head (010-0364-00); 100X attenuator head (010-0365-00); two test-point jacks (131-0258-00); coupling capacitor (011-0098-00); probe tip (206-0114-00); tip ground adaptor (013-0085-00); 5½ inch ground lead (175-1017-00); 12½ inch ground lead (175-1018-00); 3 inch cable assembly (175-0249-00); end cap (200-0834-00); three ground clips (344-0046-00); two end caps (200-0835-00); probe holder (352-0090-00); carrying case (016-0121-01); 6 inch elec lead (175-0849-00); 3 inch elec lead (175-0849-00); retractable hook tip (013-0097-01); 50 Ω voltage pickoff (017-0077-01); instruction manual.
**Weight** — Net: 1.4 kg (3.0 lb). Shipping: 2.3 kg (5.0 lb).

**ORDERING INFORMATION**

**S-3A** Sampling Head ..... **$1,965**

## S-4

### 25 ps Sampling Head

### Dc to 14 GHz Equivalent Bandwidth

### Displayed Noise <5 mV (Unsmoothed)

The S-4 Sampling Head is a 25 ps risetime unit with a 50 Ω input impedance. The S-4 can be plugged into the sampling unit or attached by a sampling head extender for remote use. A trigger pickoff within the S-4 provides a trigger signal output from the plug-in unit.
**Risetime** — 25 ps or less.
**Bandwidth** — Equivalent to dc to 14 GHz at 3 dB down.
**Transient Response** — Aberrations in the first 400 ps following a step from an S-52 Pulse Generator Head are −10%, +10% or less, total of 20% or less p-p. From 400 ps to 25 ns following a step from a 284 Pulse Generator, −0%, +10% or less, total of 10% or less, p-p with 284 pulse displayed; after 25 ns, −2%, +2% or less, total of 4% or less p-p.
**Displayed Noise** — 5 mV or less, unsmoothed; 2.5 mV, smoothed (includes 90% of dots).
**Signal Range** — Variable dc offset allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. For best dot-transient response with random-sampling sweep unit, signal amplitude should be less than 500 mV p-p.
**Input Characteristics** — Nominally 50 Ω. Safe overload ±5 V. SMA (3 mm) input connector.
**Included Accessories** — 2 ns cable with SMA connectors (015-1005-00); 10X 50 Ω SMA attenuator (015-1003-00); GR874 to SMA male adaptor (015-1007-00); SMA male-to-male adaptor (015-1011-00); 5/16 inch wrench (003-0247-00); instruction manual.
**Weight** — Net: 0.5 kg (1.0 lb). Shipping: 0.9 kg (2.0 lb).

**ORDERING INFORMATION**

**S-4** Sampling Head ..... **$2,945**

## S-5

### 1 MΩ, 15 pF Input Impedance

### Passive Probe

### Internal Trigger Pickoff

The S-5 Sampling Head is a low-noise, 1 ns risetime sampling unit with a 1 MΩ, 15 pF input impedance. When used with the included P6010 Passive Probe, the input impedance increases to 10 MΩ, 10 pF while maintaining the 1 ns risetime at the probe tip. A switch on the sampling head selects either ac or dc coupling of the input.
**Risetime** — S-5 only, 1 ns or less; with 3.5 ft P6010, 1 ns or less.
**Bandwidth** — Equivalent to dc to 350 MHz at 3 dB down at input connector or probe tip.
**Transient Response** — S-5 only (driven with a 50 Ω source terminated in 50 Ω): aberrations +2.5%, −5% or less, total of 7.5% or less p-p within 17 ns after step; +1%, −1% or less, total of 2% or less p-p thereafter.
S-5/P6010 (3.5 ft probe, properly compensated): aberrations +5%, −5% or less total of 10% or less p-p within 25 ns after step; +1%, −1% or less total of 2% or less p-p thereafter.
**Displayed Noise** — S-5 only, 500 μV or less (includes 90% of dots). S5/P6010, 5 mV or less (includes 90% of dots).
**Signal Range** — S-5 only: dc coupled, 1 V p-p from +1 V to −1 V; ac coupled, 1 V p-p. S5/P6010: dc coupled (dc + peak ac), 10 V p-p; ac coupling, dc voltage, 100 V.
**Input Characteristics** — S-5 only, 1 MΩ within 1% paralleled by 15 pF. S-5/P6010, 10 MΩ paralleled by ≈10 pF.
**Attenuator Accuracy** — Probe attenuation is 10X within 3%.
**Included Accessories** — 50 Ω termination (011-0049-01); P6010 probe package (010-0188-00); instruction mahual.
**Weight** — Net: 0.3 kg (0.6 lb). Shipping: 0.9 kg (2.0 lb).

**ORDERING INFORMATION**

**S-5** Sampling Head ..... **$1,375**

## S-6

### 30 ps Risetime

### Displayed Noise <5 mV (Unsmoothed)

### Loop-Through Input

The S-6 Sampling Head is a 50 Ω feed-through unit for high-speed applications.
**Risetime** — 30 ps or less. 35 ps or less as observed with S-52 Pulse Generator.
**Bandwidth** — Equivalent to dc to 11.5 GHz at 3 dB down.
**Transient Response** — Pulse aberrations following the steps are +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.
**Displayed Noise** — 5 mV or less, measured tangentially.
**Signal Range** — +1 V to −1 V (dc + peak ac). 1 V p-p. Dc offset allows any portion of input signal to be displayed.
**Input Characteristics** — Nominally 50 Ω, loop-through system, unterminated. SMA (3 mm) connectors. Maximum safe overload is ±5 V.
**Included Accessories** — 50 Ω termination (015-1022-00); 1 ns 50 Ω cable (015-1019-00); SMA (3 mm) female-to-female adaptor (015-1012-00); combination wrench (003-0247-00); SMA male-to-GR874 adaptor (015-1007-00); instruction manual.
**Weight** — Net: 0.5 kg (1.0 lb). Shipping: 0.9 kg (2.0 lb).

**ORDERING INFORMATION**

**S-6** Sampling Head ..... **$2,535**

**TIMING HEAD CHARACTERISTICS**

| | Bandwidth | Risetime | Application |
|---|---|---|---|
| S-51 | 1 GHz to 18 GHz trigger countdown | — | High Speed Sinewave Sampling |
| S-52 | — | ≤25 ps | High Resolution TDR |
| S-53 | Dc to 1 GHz trigger recognizer | — | General Purpose Sampling |
| S-54 | — | ≤1 ns | Medium Resolution TDR |

## S-51

### 18 GHz Countdown

### 10 ps or Less Trigger Jitter

The S-51 Trigger Countdown Head is a free-running tunnel-diode oscillator designed to provide stable sampling displays of sinewaves from 1 GHz to 18 GHz. The S-51 has a front-panel sync control that synchronizes the oscillator frequency to a subharmonic of the input signal. The output from the S-51 is available at a front-panel trigger output connector and through a rear-panel connector for internal triggering. The output signal is a direct countdown of the input and permits triggering by a standard sampling time-base unit.

**Input Signal** — Frequency range is 1 GHz to 18 GHz. Stable synchronization on signals at least 100 mV p-p, as measured separately into 50 Ω, 5 V, p-p maximum.

**Input Characteristics** — 50 Ω SMA (3 mm) connector. Open termination paralleled by 1 pF.

**Trigger Output** — Front-panel trigger output is at least 200 mV into 50 Ω, BSM type connector. Internal trigger output is at least 100 mV into 50 Ω, internally connected to sampling unit. Jitter is 10 ps or less with signals from 5 GHz to 18 GHz; 15 ps or less with signals from 1 GHz to 5 GHz. Kickout at signal input connector is 400 mV or less; kickout occurs between successive samples.

**Weight** — Net: 0.5 kg (1.0 lb). Shipping: 2.3 kg (5.0 lb).

**Included Accessory** — Instruction manual.

**ORDERING INFORMATION**

**S-51** Trigger Countdown Head ..... **$1,455**

## S-52

### 25 ps Risetime

### 200 mV into 50 Ω

### 50 Ω Source

### Pretrigger Output

The S-52 Pulse Generator Head is a tunnel-diode step generator designed for use with the 7S12 as a high resolution TDR (Time Domain Reflectometer).

For TDR applications, the S-52 features automatic bias circuit control to eliminate effects of tunnel-diode and load changes. A 50 Ω reverse termination minimizes reflections. The pulse width is sufficient for distances up to 250 ft in any cable. A pretrigger output allows the S-52 to be operated in sequential sampling systems without a delay line.

**Pulse Output** — Risetime is 25 ps or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pulse duration when used with the 7S12 in the TDR mode is typically 750 ps. Pulse duration when powered by the 7S11 is >800 ps. Pulse period 16 μs within 2 μs. Pulse aberrations following the step are +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step, +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

**Pretrigger Output** — Risetime is 1 ns or less. Amplitude into 50 Ω is at least 1 V, positive going. Pretrigger pulse duration is 4 ns. Pretrigger occurs 85 ns (within 5 ns) before the pulse output. Pretrigger to pulse output jitter is 10 ps or less. Pretrigger output is also available at rear connector for internal triggering of the sampling sweep unit.

**Output Connectors** — Pulse output uses an SMA (3 mm) connector. Pretrigger output uses a BSM connector.

**Weight** — Net: 0.3 kg (0.8 lb). Shipping: 0.5 kg (1.0 lb).

**Included Accessories** — 1 ns, 50 Ω semirigid coax delay line (015-1023-00); instruction manual.

**ORDERING INFORMATION**

**S-52** Pulse Generator Head ..... **$1,825**

## S-53

### Dc-to-1 GHz Operation

### 10 mV Sensitivity

The S-53 Trigger Recognizer Head is intended for use with the 7S12 to permit operation as a general-purpose sampling system. The S-53 supplies triggering for the 7S12.

**Input Characteristics** — Frequency range is dc to 1 GHz. Sensitivity range is 10 mV to 2 V p-p into 50 Ω. Kickout at input, ±5 mV or less.

**Output Characteristics** — Risetime is 1 ns or less. Amplitude is at least 1.5 V positive-going into 50 Ω. Pulse duration is 3 ns within 2 ns at the 50% amplitude level. Pulse period is 27 μs minimum. Trigger-to-signal delay is 15 ns or less; jitter is 15 ps or less.

**Connectors** — Trigger input connector is BNC type. Front-panel trigger output connector is BSM type. Trigger output is also available at rear connector for internal triggering.

**Weight** — Net: 0.3 kg (0.8 lb). Shipping: 0.5 kg (1.0 lb).

**Included Accessories** — 42 inch, 50 Ω cable (012-0057-01); 10X 50 Ω attenuator (011-0059-02); instruction manual.

**ORDERING INFORMATION**

**S-53** Trigger Recognizer Head ..... **$1,315**

## S-54

### 1 ns Risetime

### Low Aberrations

### 400 mV into 50 Ω

### 50 Ω Source

### Variable Pretrigger Lead Time

The S-54 Pulse Generator Head is a step generator designed for use with the 7S12 as a long line TDR unit.

Intended for TDR applications, the S-54 is 50 Ω reverse terminated to minimize reflections and has a 0 V base line to eliminate base line shift with load changes. A continuously variable front-panel control enables adjustment of pretrigger lead time. The pretrigger output allows the S-54 to be operated in sequential sampling systems without a delay line.

**Pulse Output** — Risetime is 1 ns or less. Amplitude into 50 Ω is +400 mV or greater. Pulse duration is 25 μs within 2 μs. Pulse aberrations following the step are +1.5%, −1.5%, total of 1.5% p-p, as displayed with S-1 Sampling Head. Base line level is 0 V within 20 mV, terminated in 50 Ω.

**Pretrigger Output** — Risetime is 5 ns or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pretrigger pulse duration is 20 ns or less at the 50% amplitude point. Pretrigger lead time is front panel adjustable from 120 ns or less to 1 μs or greater. Pretrigger-to-pulse-output jitter is 100 ps or less at 120 ns lead time to 1 ns or less at 1 μs lead time.

**Output Connectors** — Pulse output uses a BNC connector. Pretrigger output uses a BSM connector.

**Included Accessories** — BNC T connector (103-0030-00); 8 inch 50 Ω cable (012-0118-00); instruction manual.

**Weight** — Net: 0.3 kg (0.8 lb). Shipping: 0.5 kg (1.0 lb).

**ORDERING INFORMATION**

**S-54** Pulse Generator Head ..... **$1,180**

**OPTIONAL ACCESSORIES**

**CT-1 Current Transformer** — With GR Cable. Order 015-0041-00 ..... **$160**
**P6056 10X Passive Probe** — Order 010-6056-03 ..... **$185**
**P6057 100X Passive Probe** — Order 010-6057-03 ..... **$190**
**Coupling Capacitor, GR874-K** — Order 017-0028-00 .. **$100**
**Power Divider GR874-TPD** — Order 017-0082-00 ..... **$375**
**GR to BNC Adaptor** — Order 017-0063-00 ..... **$43**
**Probe Tip-to-BNC Adaptor** — Order 013-0084-01 ..... **$8.00**
**Probe Tip-to-GR Adaptor** — Order 017-0076-00 ..... **$55**
**Probe Tip-to-GR Terminated Adaptor** — Order 017-0088-00 ..... **$50**

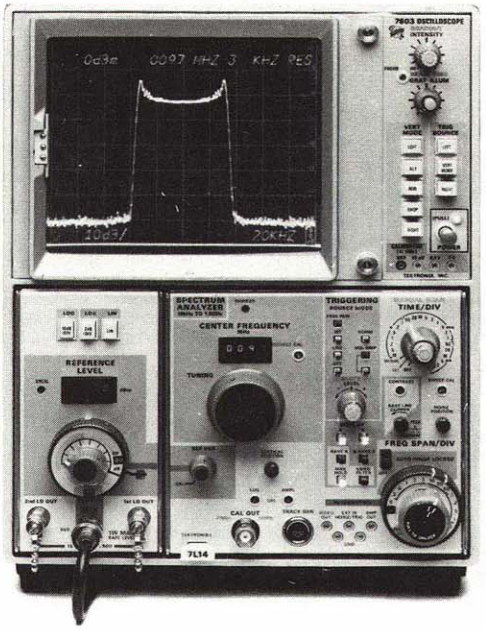
**OPTIONAL SAMPLING HEAD ACCESSORIES**
**With SMA (3 mm) Connectors**

**2X 50 Ω Attenuator** — Order 015-1001-00 ..... **$120**
**5X 50 Ω Attenuator** — Order 015-1002-00 ..... **$120**
**10X 50 Ω Attenuator** — Order 015-1003-00 ..... **$120**
**50 Ω Termination** — Order 015-1004-00 ..... **$60**
**2 ns 50 Ω Signal Cable** — Order 015-1005-00 ..... **$90**
**5 ns 50 Ω Signal Cable** — Order 015-1006-00 ..... **$140**
**Female-to-GR874 Adaptor** — Order 015-1007-00 ..... **$100**
**Male-to-GR874 Adaptor** — Order 015-1008-00 ..... **$100**
**Male-to-N Female Adaptor** — Order 015-1009-00 ..... **$25**
**Male-to-7 mm Adaptor** — Order 015-1010-00 ..... **$175**
**Male-to-Male Adaptor** — Order 015-1011-00 ..... **$20**
**Female-to-Female Adaptor** — Order 015-1012-00 ..... **$9.25**
**Coupling Capacitor** — Order 015-1013-00 ..... **$200**
**50 Ω Power Divider T** — Order 015-1014-00 ..... **$200**
**500 ps 50 Ω Semrigid Cable** — Order 015-1015-00 ..... **$25**
**SMA T Adaptor** — Order 015-1016-00 ..... **$35**
**SMA Male-to-BNC Female Adaptor** — Order 015-1018-00 ..... **$8.00**
**1 ns 50 Ω Cable** — Order 015-1019-00 ..... **$120**
**SMA Male Short-Circuit Termination** — Order 015-1020-00 ..... **$17.50**
**SMA Female Short-Circuit Termination** — Order 015-1021-00 ..... **$24**
**SMA Male 50 Ω Termination** — Order 015-1022-00 ..... **$32**

**With BNC Connectors**

**50 Ω Feed-through Termination** — Order 011-0049-01 . **$25**
**50 Ω Feed-through (5 W)** — Order 011-0099-00 ..... **$40**
**50 Ω 2X Attenuator** — Order 011-0069-02 ..... **$35**
**50 Ω 2.5X Attenuator** — Order 011-0076-02 ..... **$35**
**50 Ω 5X Attenuator** — Order 011-0060-02 ..... **$35**
**50 Ω 10X Atteuator** — Order 011-0059-02 ..... **$35**
**50 Ω 18 in, Coaxial Cable** — Order 012-0076-00 ..... **$17**
**50 Ω 42 in, Coaxial Cable** — Order 012-0057-01 ..... **$17**

# VERSATILE HIGH PERFORMANCE PLUG-IN SPECTRUM ANALYZERS




## 7L14

**10 kHz to 1800 MHz**

**Digital Storage and Averaging**

**Automatic Phase Lock**

**Swept Frequency Measurements with TR 502**

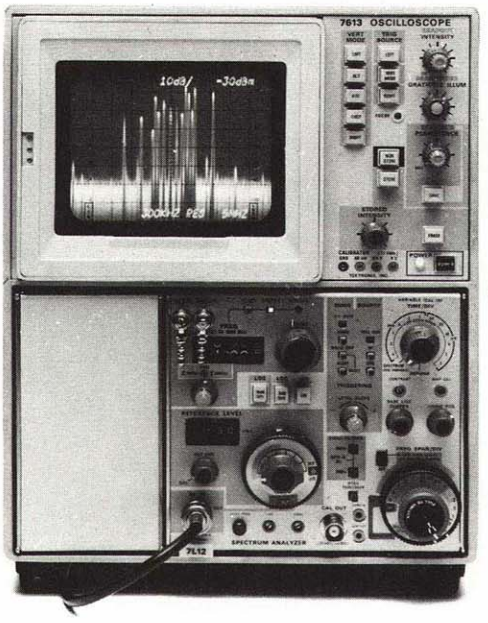
**Input Limiter for Extra Input Protection**

The Tektronix 7L14 is a VHF/UHF analyzer with digital storage. It provides high performance in the 10 kHz to 1.8 GHz range. Measurements for RFI/EMI, FM, TV, avionics, navigation, two-way and other communications systems are made with accuracy and convenience.

Resolution bandwidth can be varied from 30 Hz to 3 MHz over the entire frequency range. Automatic phase lock ensures excellent stability—incidental FM is ≤13 Hz peal-to-peak. Phase noise sidebands are no greater than −70 dBc at 25 resolution bandwidths away.

All this gives you the critical accuracy necessary for design and proof-of-performance measurements. Check broadband RF networks, filter networks, amplifiers, and more...easily and economically.

For a complete description of the 7L14 see page 210.




## 7L12

**100 kHz to 1800 MHz**

**Automatic Phase Lock**

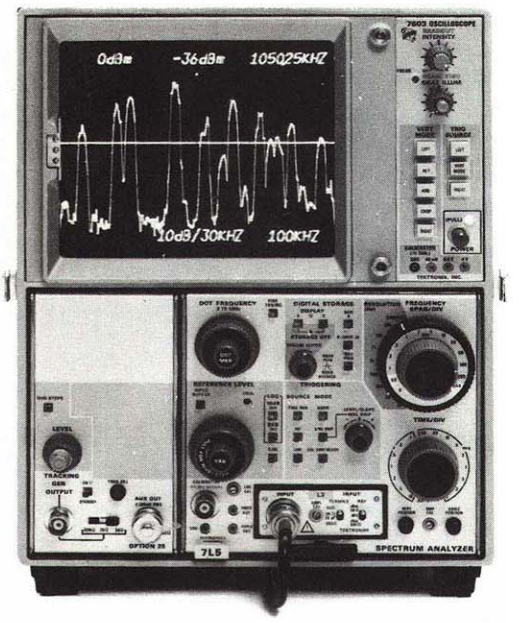
**Swept Frequency Measurements with the TR 502**

The 7L12 is a popular instrument in applications not requiring the resolution, low-end coverage, and digital storage of the 7L14. Resolution bandwidth can be varied from 300 Hz to 3 MHz, with −115 dBm sensitivity at 300 Hz. Automatic phase lock results in good stability; residual FM is ≤200 Hz peak-to-peak.

The 7L12 meets the measurement requirements of many AM, FM, two-way radio and other communications systems.

The 7L12 has a 70 dB spurious-free display dynamic range; low level noise measurements are made accurately, easily.

For a complete description of the 7L12 see page 211.




## 7L5

**20 Hz to 5 MHz**

**Digital Storage and Averaging**

**Synthesizer Tuning**

**Three-Knob Operation**

**Swept Frequency Measurements with Option 25**

**Preset Reference Level and Dot Frequency for Extra Input Protection**

**Selectable Input Impedance**

**Reference Level Selection in 1 dB and 10 dB Steps**

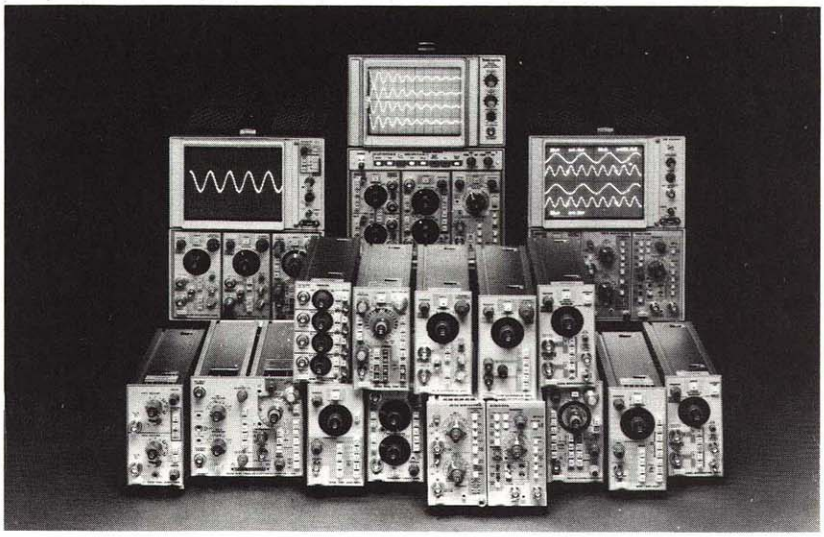
**Absolute Calibration in dBm, dBV, or Volts/Div**

The Tektronix 7L5 provides easy-to-use low-frequency measurement capability. The 7L5 can cover 20 Hz to 5 MHz in one display. Resolution bandwidth can be varied from 10 Hz to 30 kHz, with residual FM of no more than 1 Hz peak-to-peak. Comparing baseband channel performance is easy because the 7L5 switches from a single channel to a 60-channel supergroup without retuning. You see all channel amplitudes at a glance, side-by-side.

Probe-compatible plug-in input modules provide a variety of impedances for the 7L5. The L3 may be switch-selected to 50 Ω, 600 Ω or 1 MΩ. The L3 Option 01 is switch-selectable to 75 Ω, 600 Ω or 1 MΩ.

For a complete description of the 7L5 see page 212.

# 5000 SERIES INSTRUMENTS



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5000 Series Nonstorage Mainframes .... **276, 284**
5000 Series Color Oscilloscope ..... **278**
5000 Series Plug-ins ..... **279-283, 286**
5000 Series Digitizing Oscilloscope ..... **344**


**Digital Storage Capability**
The 5223 Digitizing Oscilloscope provides digital storage at the touch of a button, intensified pretrigger viewing, equivalent time sampling, and X-Y displays. The optional IEEE Standard 488 interface is ideal for physical, mechanical and biomedical applications.

**Performance Value**
Designed for the cost-conscious user as an alternative to the monolithic scope, the 5400 Series gives you 50 MHz bandwidth in both nonstore and variable persistence storage mainframes with CRT readout.

**Maximum Flexibility**
The 5100 Series is ideal for low frequency applications such as medical and mechanical measurements requiring up to 2 MHz bandwidth. It gives you unparalleled choices in measurement flexibility such as dual-beam, split-screen, bistable storage displays, differential inputs and spectrum analysis.

The 5116 combined with a 5D10 Waveform Digitizer provides unique three-color display in addition to the digital storage capabilities and features of the 5D10.

- **Low Cost**
- **2 MHz, 10 MHz or 50 MHz Bandwidth**
- **Sampling to 1 GHz**
- **Seven Oscilloscope Models**
- **Wide Choice of Plug-Ins**
- **Color, Digital, Dual-Beam & Storage Displays**
- **CRT Readout (5400 Series Only)**
- **Large 6.5 Inch CRT (8 x 10 Div)**
- **10 μV/Div High Gain Differential Amplifier**
- **One to Eight Trace Capability**
- **Delayed-Sweep Time Bases**
- **Y-T or X-Y Operation**
- **Bench-to-Rack Convertibility**

The 5000 Series oscilloscopes are designed to provide optimum versatility and performance at the lowest possible price.

### 5100 SERIES OSCILLOSCOPES

Four 5100 Series oscilloscope mainframes are available: the 5110 single-beam nonstorage mainframe, the 5111A single-beam storage mainframe, the 5113 dual-beam storage mainframe, and the 5116 single-beam nonstorage mainframe with color shutter. All of these mainframes feature 2 MHz vertical systems with large 6½ inch CRTs. Each will house up to three plug-in units.

A wide choice of plug-in units is available for use with each of these mainframes. Among these are the variety of single-, dual-, anad four-trace amplifiers, two time-bases, a curve tracer, a 1 GHz dual-trace sampler, and the 5D10 Waveform Digitizer.

When used with the 5D10 Waveform Digitizer, the 5116 mainframe provides a unique three-color display, with readout, in addition to the digital storage capabilities of the 5D10.

### 5223 DIGITIZING OSCILLOSCOPE

You can get the benefits of digital storage, along with the time-tested advantages of a conventional analog scope, in the 10 MHz 5223 Digitizing Oscilloscope. Combined in one powerful, convenient oscilloscope are pushbutton ease, high quality waveform display, pretrigger signal manipulation, and optional GPIB interface, plus real-time analog display capability.

Use the 5223 in the digital storage mode to capture repetitive events up to 10 MHz in frequency or single-shot events up to 100 kHz in frequency. The maximum sample rate is 1 MHz; storage capacity is 1024 bits per vertical compartment.

The digitized display will never fade or bloom, so you get more accurate measurements, more conveniently. High 10-bit vertical resolution gives you an accurate representation of your signals.

For further information on the 5223 Digitizing Oscilloscope, see page 344 in the Digitizer Section.

## 5400 SERIES OSCILLOSCOPES

Two 5400 Series display units are presently available: a single-beam, nonstorage display and a variable persistence storage display. Both feature CRT readout of plug-in scale factors, three plug-in compartments and benchmount-to-rackmount convertibility.

The 5400 Series offers 50 MHz bandwidth and is capable of satisfying a wide range of measurement needs. It features readout of plug-in scale factors on the CRT (except with plug-ins having a suffix N: 5A22N, 5B10N, etc.). This feature, previously available only on more sophisticated oscilloscopes, allows you to make measurements more quickly and conveniently. The CRT readout can also be externally accessed (Option 03).

## PLUG-IN VERSATILITY

A wide choice of plug-ins is available in the 5000 Series family. All these plug-ins are compatible with the 5400 Series, and all but six are compatible with 5100 Series mainframes.

The amplifier plug-ins include single, dual, and four trace units, and various differential amplifiers. The time-base plug-ins include single, dual, and delaying sweep units, and a digital time base.

Three special-purpose plug-ins are also available. The 5CT1N is a semiconductor curve tracer plug-in. It allows characteristic curves of transistors, FETs, diodes and other semiconductor devices to be displayed on the CRT. The 5S14N, a general-purpose dual-trace, delayed sweep sampler, extends the bandwidth of the 5100, the 5400 Series, and the 5223 to 1 GHz at 2 mV sensitivity.

The 5D10 is a dual channel waveform digitizer with cursors, CRT scale factor readout, roll mode and plotter output.

Back-lighted knob skirts on the plug-ins provide scale-factor readout. The correct scale factor is automatically indicated when using the X10 magnifier and the recommended 1X and 10X probes. In addition, the 5400 Series automatically presents correct scale factors on the CRT when used with non-N suffix plug-ins. This feature helps reduce human errors and enables photographic recording of measurement conditions.

### CARTS

**SCOPE-MOBILE® Carts** — For cabinet models, order TEK Lab Cart, Model 3.

### CAMERAS

**All 5100 Series** — C-5C or C-4 Option 02, suitable for repetitive or stored traces.
**5100 Storage Instruments, 5440 (with P back), 5441 (with G back)** — C-59A, general purpose.
**For full details see camera section on page 420.**

### OPTIONAL ACCESSORIES

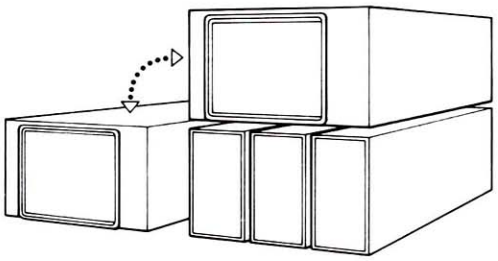
**Blank Plug-in Kit** — Order 040-0818-03
**Blank Panel** — Order 016-0195-03
**Viewing Hoods** — Order 016-0154-00
or Order 016-0452-00 folding
**Protective Cover** — Order 016-0544-00
**For full details see accessories section on page 417.**

### 5000 SERIES MAINFRAME/PLUG-IN COMPATIBILITY CHART

F = Full Compatibility  L = Limited Compatibility  0 = No Compatibility

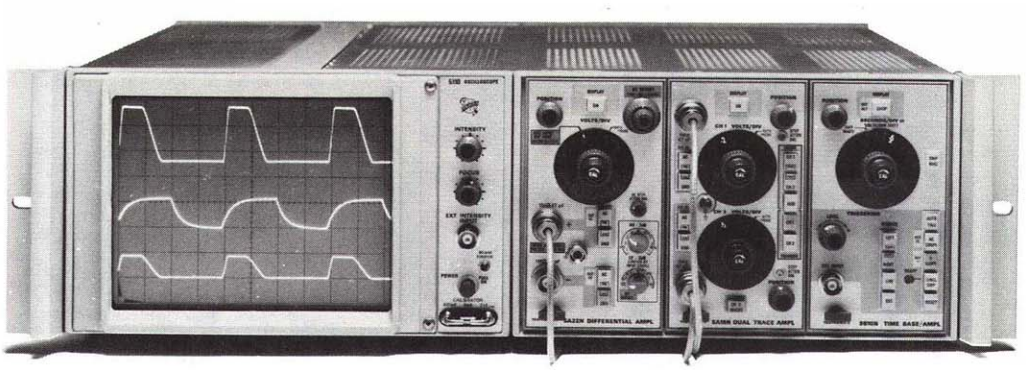
| Plug-ins | | 5223 10 MHz Digital Storage | 5110 2 MHz Nonstorage | 5111A 2 MHz CRT Storage | 5113 2 MHz Dual Beam CRT Storage | 5116 2 MHz Nonstorage with Color*1 | 5440 50 MHz Nonstorage with Readout | 5441 50 MHz Variable Persistence with Readout |
|---|---|---|---|---|---|---|---|---|
| | PAGE | 344 | 276 | 276 | 277 | 278 | 284 | 285 |
| **5A14N** Four-Trace, 1-MHz, 1 mV/div | 280 | F | F | F | F | L*1 | L*2 | L*2 |
| **5A15N** Single-Trace, 2-MHz, 1 mV/div | 280 | F | F | F | F | L*1 | L*2 | L*2 |
| **5A18N** Dual-Trace, 2-MHz, 1 mV/div | 280 | F | F | F | F | L*1 | L*2 | L*2 |
| **5A19N** Single-Trace Differential, 2-MHz, 1 mV/div | 281 | F | F | F | F | L*1 | L*2 | L*2 |
| **5A21N** Single-Trace Differential, 1 MHz, 50 μV/div, 0.5 mA/div | 281 | F | F | F | F | L*1 | L*2 | L*2 |
| **5A22N** Single-Trace Differential, 1-MHz, 10 μV/div | 282 | F | F | F | F | L*1 | L*2 | L*2 |
| **5A26** Dual-Trace Differential, 1-MHz, 50 μV/div | 282 | F | F | F | F | L*1 | F | F |
| **5A38** Dual-Trace, 35-MHz, 10 mV/div | 286 | F | 0 | 0 | 0 | 0 | F | F |
| **5A48** Dual-Trace, 50-MHz, 1 mV/div*4, | 286 | F | 0 | 0 | 0 | 0 | F | F |
| **5B10N** Single-Sweep Time Base/Amplifier, 1 μs to 5 s | 283 | L*3 | F | F | F | L*1 | L*2 | L*2 |
| **5B12N** Dual-Sweep Time Base, A-1 μs to 5 s, B-2 μs to 0.5 s | 283 | L*3 | F | F | F | L*1 | L*2 | L*2 |
| **5B25N** Digital Time Base for 5223, 0.2 μs to 5 s | 345 | F | 0 | 0 | 0 | 0 | L*2 | L*2 |
| **5B40** Single-Sweep Time Base, 0.1 μs to 5 s | 286 | L*3 | 0 | 0 | 0 | 0 | F | F |
| **5B42** Delaying Time Base, A-0.1 μs to 5 s, B-0.1 μs to 0.5 s | 286 | L*3 | 0 | 0 | 0 | 0 | F | F |
| **5CT1N** Semiconductor Curve Tracer | 282 | F | F | F | F | L*1 | L*2 | L*2 |
| **5D10** Waveform Digitizer | 279 | L*3,*4 | L*4 | L*4 | L*4 | F | L*4 | L*4 |
| **5S14N** Sampling Unit | 283 | F | F | F | F | L*1 | L*2 | L*2 |

*1 *The 5116 must be used with 5D10 to obtain color display.*
*2 *Those plug-ins with an "N" suffix do not implement the readout feature of the 5440 and 5441.*
*3 *Only the 5B25N implements the digital storage feature of the 5223.*
*4 *The 5D10 produces a color display only in the 5116.*



**CONVERSION KITS**

**Cabinet-to-Rackmount** Order 040-0583-03 ..... **$155**
**Rackmount-to-Cabinet** Order 040-0584-04 ..... **$180**
**Rackmount-to-Cabinet (R5223 Only)**
Order 040-0975-01 ..... **$275**
**Cabinet-to-Rackmount (5223 Only)**
Order 040-0976-04 ..... **$375**



*5000 Series rackmount oscilloscopes and cabinet-to-rackmount kits include complete slide out tracks and mounting hardware interface with standard 19 inch racks.*

## RECOMMENDED OPTIONAL PROBES FOR 5000 SERIES AMPLIFIER PLUG-INS

| Amplifier Plug-ins | Voltage Probe | Attenuation | Standard Length | Features | Package Number |
|---|---|---|---|---|---|
| 5A14N<br>5A15N<br>5A18N | P6108*2 | 10X | 2 m | Full bw, modular (not compatible with CRT readout). | 010-6108-03 |
| | P6062B | 1X/10X | 6 ft | Full bw, switchable attenuation, ground reference button. | 010-6062-13 |
| 5A13N<br>5A21N*1<br>5A22N<br>5A26 | P6062B | 1X/10X | 6 ft | Full bw, switchable attenuation, ground reference button. | 010-6062-13 |
| | P6101*2 | 1X | 2 m | Full bw, miniature. Modular construction simplifies repair. | 010-6101-03 |
| | P6055 | Adjustable to 10X | 3.5 ft | Adjustable attenuation. Will give up to 20,000; 1 CMRR when used in pairs. (5A21N, 5A22N and 5A26). | 010-6055-01 |
| 5A38<br>5A48<br>5D10 | P6122*2 | 10X | 1.5 m | Full bw, miniature, low cost, modular. | 010-6122-01 |
| | P6105 | 10X | 2 m | Full bw, miniature. Modular construction simplifies repair. | 010-6105-03 |
| | P6062B | 1X/10X | 6 ft | Switchable attenuation (full bandwidth in the 10X position) ground reference button. | 010-6062-13 |
| | P6101*2 | 1X | 2 m | Miniature, modular (reduced bandwidth). | 010-6101-03 |

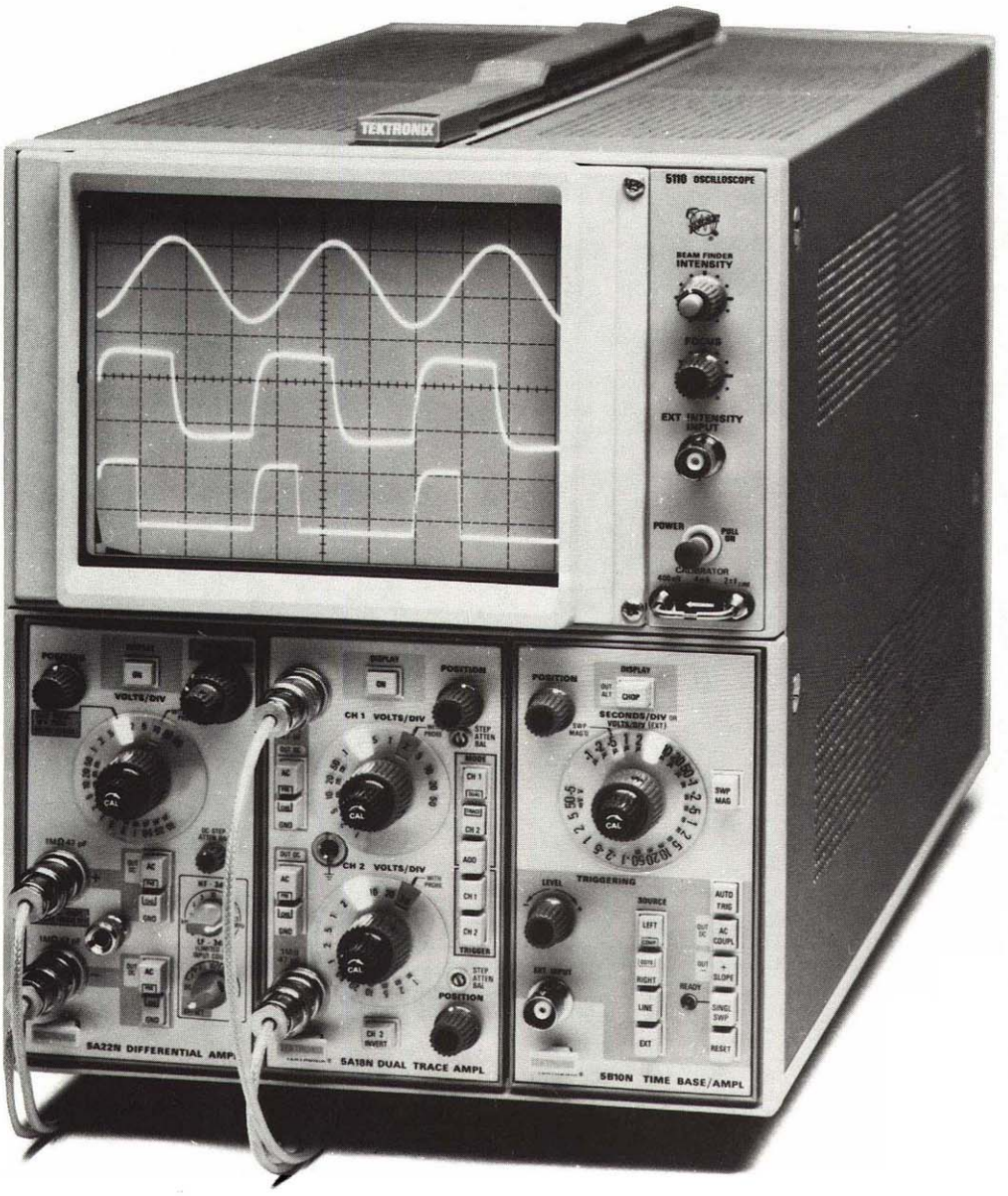
**1 The 5A21N also provides direct access to current probe P6021. Order 5A21N, Option 01 for 5A21N Amplifier and Current Probe package.*
**2 Does not include readout capability.*

## 5000 SERIES INSTRUMENTS—PHYSICAL CHARACTERISTICS

| | 5223 | | | | 5100 and 5400 Series | | | | Plug-ins | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cabinet | | Rackmount | | Cabinet | | Rackmount | | Single Width | | Double Width | |
| **Dimensions** | **mm** | **in** | **mm** | **in** | **mm** | **in** | **mm** | **in** | **mm** | **in** | **mm** | **in** |
| Width | 213 | 8.4 | 483 | 19.0 | 213 | 8.4 | 483 | 19.0 | 66 | 2.6 | 132 | 5.2 |
| Height | 328 | 12.9 | 178 | 7.0 | 302 | 11.9 | 133 | 5.25 | 127 | 5.0 | 127 | 5.0 |
| Depth | 572 | 22.5 | 569 | 22.4 | 518 | 20.4 | 483 | 19.0 | 305 | 12.0 | 305 | 12.0 |
| **Weight ≈** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** |
| Net | 16.9 | 37.3 | 19.1 | 42.0 | 10.4 | 23.0 | 10.9 | 24.0 | 1.3 | 2.8 | 2.6 | 5.8 |
| Shipping | 20.5 | 45.0 | 23.6 | 52.0 | 10.5 | 32.0 | 19.5 | 43.0 | 4.5 | 10.0 | 4.9 | 10.8 |

## 5000 SERIES OSCILLOSCOPES APPLICATION NOTES

| Title | Featuring | Request Number |
|---|---|---|
| STRUCTURAL TESTING, The Digitizing Approach | 5223/5B25N/5A18N Single-shot techniques. Multitrace using transducers. | W-4461-1 |
| BIOPHYSICAL DATA RETRIEVAL, The Digitizing Approach | 5223/5B25N/5A18N Roll mode, chart recorder output. | W-4462-1 |
| RECORDING ELECTRO-PHYSIOLOGICAL NERVE ACTIVITY Using a plug-in oscilloscope | 5113/5A26/5A22N Low level measurements and storage. | AX-3746 |
| INTERPRETING MECHANICAL MEASUREMENTS WITH THE PLUG-IN OSCILLOSCOPE | 5111/5A22N/5A18N Transducer measurements and storage. | A-3533-1 |
| SIMULTANEOUS DISPLAY OF TWO INDEPENDENT X-Y SIGNAL PAIRS | 5111/5A15/5A15N/5A18N. Dual X-Y techniques, engine analysis. | AX-4114 |
| SIMULTANEOUS X-Y, Y-T DISPLAYS | 5111/5A15/5A15N/5B12N. X-Y, Y-T techniques. Biomedical application. | AX-4113 |
| CUSTOM PLUG-IN IDEAS FOR 5000 SERIES SCOPES | Recommended starter note for customers considering custom plug-in project. | AX-3758 |
| A HIGH RESOLUTION 60 Hz NOTCH FILTER | Construction project using a commercial module in our plug-in kit. Preconditions signals by removing 60 Hz hum. | AX-4031 |
| A TRUE RMS CONVERTER blank plug-in kit. Measures true RMS up to 200 V RMS. | Construction project using thermal true RMS converter module in our | AX-4112 |




## 5100 Series Oscilloscopes

**Low Cost**

**Dc to 2 MHz**

**Sampling to 1 GHz**

**Wide Choice of Plug-ins**

**Rear Panel Signal Outputs Optional**

**See Common Characteristics on the following page.**

For information on Mechanical Transducers see page 455.

## 5110/R5110

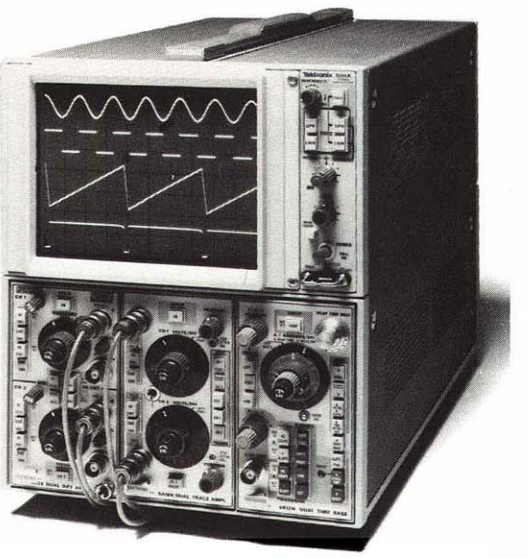
**Lowest Cost Single-Beam Nonstorage Oscilloscope with Plug-in Configurability**

**8 Channels at 1 mV/div, 4 Channels at 50 μV/div, 2 Channels at 10 μV/div, with Appropriate Amplifiers**

The 5110 is a single-beam nonstorage oscilloscope featuring a large diagonal 6.5 inch (1.27 cm/div) CRT.

Tailor your measurement needs with the appropriate plug-in units to obtain high-gain differential (10 μV/div), four channel differential at 50 μV/div, eight-channel displays at 1 mV/div. Or choose from our single-trace or dual-trace basic amplifiers and time-base plug-ins to suit the special needs of education and industry.

When using two amplifiers and a dual time base in the dual-sweep mode, the two sweeps are slaved individually to the two amplifiers.



## 5111A/R5111A

**Single-Beam Storage Oscilloscope**

**Bistable, Split-Screen Display**

**Stored Writing Speed**
**20 divs/ms in Normal Mode**
**50 divs/ms in Enhanced Mode**
**or**
**200 divs/ms in Normal Mode**
**800 divs/ms in Enhanced Mode with Option 03**

The 5111A incorporates the time proven features of the 5111 plus improvements that futher extend the usefulness of this popular instrument.

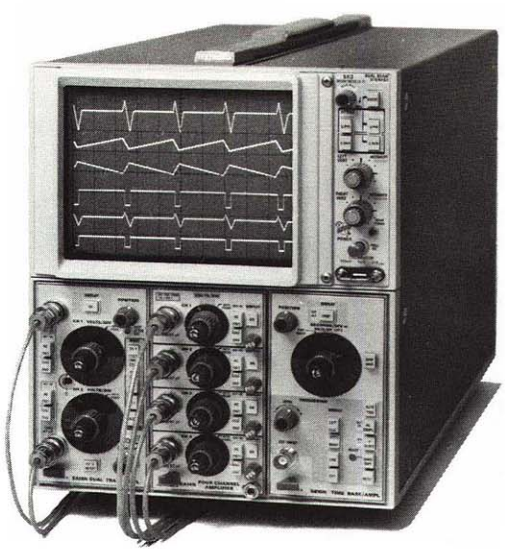
In addition to the normal storage function, the 5111A incorporates an Enhanced Mode which extends the stored writing speed to 50 div/ms.

For those applications where even greater stored writing speed is needed, we offer Option 03, Fast Writing Speed CRT. Option 03 provides ten times the standard stored writing speed at lower stored brightness.

The 5111A is a single-beam, split-screen, bistable oscilloscope with a large-screen, 6½ in diagonal (1.27 cm/div) display.

The 5111A extends measurement capability into areas requiring retention of single and multitrace displays for long-term examination and/or photography. It is particularly useful for recording low and medium speed displays like those found in semi-conductor curve tracing, sampling, vibration analysis, and the biophysical sciences. Up to eight signals can be displayed with 5A14N plug-ins.

When using two amplifiers and a dual time-base plug-in in the dual-sweep mode, the sweeps are slaved individually to the two amplifiers.



## 5113/R5113

**Dual-Beam Bistable Storage Oscilloscope**

**Two Independent Vertical Systems**

**Two Single-Shot Display Signals without Timesharing, or up to Eight Signals in the Chop Mode**

**Split-Screen Storage**

**Stored Writing Speed ⩾20 div/ms**

The 5113 is a dual-beam bistable storage oscilloscope featuring easy-to-use split-screen storage. Stored writing speed is at least 20 div/ms. View time is at least one hour at normal intensity and can be increased to ten hours at reduced intensity.

The 5113 can display two simultaneous events, either single-shot or repetitive, against a common time base within the bandwidth and writing rate limits of the system. Both beams are driven by one set of horizontal deflection plates.

The 5113 is particularly useful in biomedical research where low-repetition-rate stimulus/response potentials need to be observed and recorded.

## 5000 SERIES MAINFRAME COMMON CHARACTERISTICS

These characteristics are for the 5110/R5110, 5111A/R5111A, 5113/R5113 and 5116 unless otherwise indicated.

### VERTICAL SYSTEM

**Channels** — Left and center plug-in compartments compatible with all 5100 Series plug-ins.

**Deflection Factor** — Determined by plug-in.

**Bandwidth** — 2 MHz, determined by plug-in.

**Chopped Mode** — (5110/R5110, 5111A/R5111A, 5116) The mainframe vertical amplifier will chop between left and center plug-in compartments, and/or between two or more amplifier channels. The total time segment per channel is ≈5 μs, consisting of ≈4 μs displayed, ≈1 μs blanked. Chop or alternate mode is selected at the time base unit.

**Chopped Mode** — (5113/R5113) The left and right mainframe vertical amplifiers are dedicated to the left and center plug-in compartments. Each mainframe vertical amplifier will chop between two or more channels in their associated plug-in compartments. No channel switching is necessary between left and center plug-in compartments. The total time segment per channel is ≈5 μs, consisting of 4 μs displayed, ≈1 μs blanked. Chop or alternate mode is selected at the time base unit.

**Alternate Mode** — (5110/R5110, 5111A/R5111A, 5116) Each amplifier plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before switching to the second amplifier.

**Alternate Mode** — (5113/R5113) Single-trace amplifiers are swept full time. Each channel of a multitrace amplifier is swept once before switching to the next channel. No channel switching is necessary between left and center plug-in compartments.

### HORIZONTAL SYSTEM

**Channel** — Right-hand plug-in compartment compatible with all 5100 Series plug-ins.

**Fastest Calibrated Sweep Rate** — 0.1 μs/div (X10 mag) with 5B10N or 5B12N.

**X-Y Mode** — Phase shift within 1° from dc to 100 kHz.

### CRT AND DISPLAY FEATURES

**CRT** — Internal 8 x 10 div (1.27 cm/div) parallax-free, nonilluminated graticule.*1

**Accelerating Potential** — 3.5 kV.

**Phosphor** — 5110/R5110: GH (P31) standard, GM (P7) or BE (P11) optional. 5111A/R5111A: Equivalent to GJ (P1). 5113/R5113: Similar to GJ (P1).

**Maximum Stored Writing Speed (5111A and 5113 only)** — 5111A/R5111A: At least 20 div/ms in the Normal Mode and 50 div/ms in the Enhanced Mode. 5113/R5113: At least 20 div/ms.

**With Option 03, Fast Writing Speed CRT (5111A and 5113 only)** — At least 200 div/ms (center 6 x 8 div) in the Normal Mode and 800 divs/ms (center 6 x 8 div) in the Enhanced Mode.*1

**Storage View Time (5111A and 5113 Only)** — At least 1 hr at normal intensity; up to 10 hr at reduced intensity, after which time it may be increased to original level.

**Erase Time (5111A and 5113 Only)** — ≈250 ms.

**1 Illuminated graticule available at extra cost.*

### OTHER CHARACTERISTICS

**Ambient Temperature** — 5110, 5111A, 5113: Performance characteristics valid from 0°C + 50°C. 5116/R5116: Performance characteristics valid from 0°C to +45°C.

**Line Voltage Ranges** — 100, 110, 120, 200, 220, and 240 V ac ±10% (except that maximum input should not exceed 250 V ac). Internally selected with quick change jumpers.

**Line Frequency Range** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 110 W.

**External Intensity Input** — +5 V turns beam on from off condition. −5 V turns beam off from on condition. Frequency range dc to 1 MHz. Input R and C is ≈10 kΩ paralleled by ≈40 pF. Maximum input ±50 V (dc + peak ac.)

**Calibrator** — Voltage output 400 mV within 1%. Current output (loop) 4 mA within 1%. Frequency is 2 times line frequency.

**Beam Finder** — Positions beam on screen regardless of vertical and horizontal position control settings.

### REAR PANEL SIGNAL OUTPUTS
**Option 07**

**Left and Center Compartments** — Two BNC connectors provide access to the CRT related signals from the left and center plug-in amplifiers. Sensitivity: 0.5 V/CRT division. Output impedance: 1 kΩ.

**Right Compartment** — Sweep: One BNC connector provides access to the CRT-related sweep waveform. Sensitivity is 0.5 V/CRT division; positive-going sawtooth, ⩾5 V. Output Impedance is 1 kΩ. Gate: One BNC connector provides access to TTL compatible gate. Positive-going, coincident with displayed sweep.

**X-Y Mode** — CRT-related X-Y signals are available at the appropriate rear panel connectors when amplifier plug-ins are used in either the left or center compartment and the right compartment to display X-Y information. Sensitivity (X-Y): 0.5 V/CRT division.

**Dimensions and Weights** — See page 275.

### INCLUDED ACCESSORY (5110/R5110, 5113/R5113)
Instruction manual.

### INCLUDED ACCESSORIES (5111A/R5111A)
Power cord (161-0066-00); instruction manual.

## ORDERING INFORMATION
**(PLUG-INS NOT INCLUDED)**

### Cabinet Models
**5110** Oscilloscope ..... **$1,610**
**5111A** Oscilloscope ..... **$2,605**
**5113** Oscilloscope ..... **$3,785**

### Rackmount Models
**R5110** Oscilloscope ..... **$1,675**
**R5111A** Oscilloscope ..... **$2,605**
**R5113** Oscilloscope ..... **$3,840**

**Option 02** — Protective Panel Cover (Cabinet Models Only). The cover protects the front panel and knobs during transportation and storage ..... **+$38**
**Option 03** — Fast Write CRT (5111A/R5111A and 5113/R5113 Only). Increases stored writing speed to 200 div/ms (center 6 x 8 div). ..... **+$150**
**Option 07** — Add Rear Panel Signals Out (All Models) **+$125**
**Option 76** — GM (P7) Phosphor (5110, R5110 Only) .. **+$50**
**Option 78** — BE (P11) Phosphor (5110, R5110 Only) . **+$50**

### CONVERSION KITS
**Cabinet-to-Rackmount Conversion Kit** — Order 040-0583-03 ..... **$155**
**Rackmount-to-Cabinet Conversion Kit** — Order 040-0584-04 ..... **$180**
**Protective Panel Cover Kit** — Order 040-0620-00 ..... **$38**
**Rear Panel Signal Outputs Conversion Kit (Option 07)** — Order 040-0915-02 ..... **$230**

### INTERNATIONAL POWER CORDS AND PLUG OPTIONS
**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 , 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

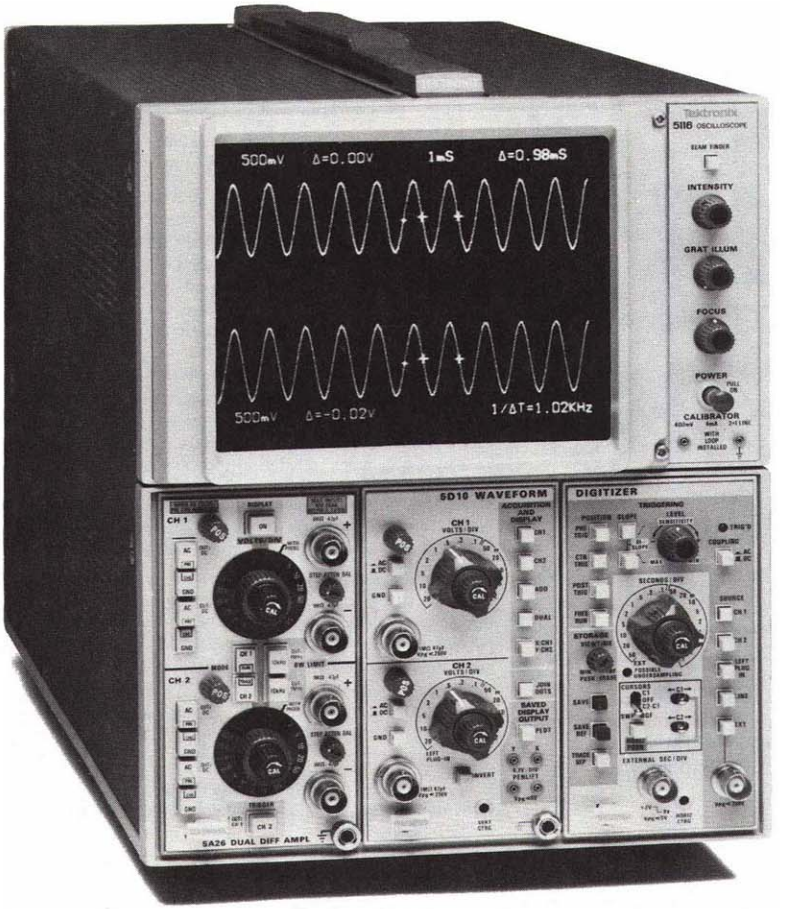
**For recommended cameras refer to page 421.**
**For mechanical transducers see page 456.**

# 5116

**Three Color, High Resolution Digital Storage Display with 5D10**

**Convergence Not Required, Single Beam Design**

**Accepts Full Range of 5100 Series Amplifiers for Preconditioning or Noncolor Applications**




The 5116 Oscilloscope, when used with a Tektronix 5D10 Waveform Digitizer, provides a unique three-color display in addition to the digital storage capabilities and features of the 5D10.

Color enhances individual trace and readout identification, thereby providing a much improved user interface. The coding capabilities afforded by color allow for interpretation and differentation of data more quickly, reduced measurement errors, and improved resolution by using the full screen for overlapping signals.

Permanent color records are made with either a Tektronix camera or with the 5D10 Waveform Digitizer plotter output.

Left vertical plug-in may be used to precondition up to two signals for Channel 2 of the 5D10. For example, plug-ins such as the 5A21N, 5A22N and 5A26 can provide differential performance with sensitivities ranging to 10 μV/div (5A22N). The 5D10 can acquire a total of three signal channels when using the Channel 2 left plug-in acquisition feature. The left vertical plug-in can also be used without the acquisition feature of the 5D10 to view a signal directly from the amplifier.

When used in noncolor applications, the wide variety of 5000 Series plug-ins are available to tailor your system for specific applications. These plug-in units range from high gain differential (10 μV/div), four channel differential (50 μV/div), eight channel (1 mV/div) amplifiers, plus economical basic amplifiers and time base plug-in units.

## CHARACTERISTICS

### CRT AND DISPLAY FEATURES

**CRT** — Internal 8 x 10 div (1.27 cm/div) parallax-free, illuminated graticule.

**Accelerating Potential** — 4.5 kV.

**Color Shutter** — With 5D10: Three-color display of blue-green, orange, and neutral. Without 5D10: Blue-green display.

### VERTICAL SYSTEM

**Channels** — Left and center plug-in compartments compatible with all 5100 Series plug-ins. Center and right plug-in compartments accept the 5D10 Waveform Digitizer for dual-trace color and digital storage of displays.

**Chopped Mode** — The mainframe vertical amplifier will chop between left and center plug-in compartments, and/or between two or more amplifier channels. The time segment per channel is ≈5 μs, consisting of ≈4 μs displayed, ≈1 μs blanked. Chop or alternate mode is selected at the time base unit.

**Alternate Mode** — Each amplifier plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before switching to the second amplifier.

### HORIZONTAL SYSTEM

**Channel** — Right-hand plug-in compartment compatible with all 5100 Series plug-ins. The 5D10 utilizes the center and right-hand compartments for dual trace color and digital storage of displays.

**Fastest Calibrated Sweep Rate** — With 5D10; 0.1 ms/div. With 5B10N or 5B12N: 0.1 μs/div (X10 mag).

**X-Y Mode** — Phase shift within 1° from dc to 100 kHz.

### OTHER CHARACTERISTICS

**Ambient Temperature** — Performance characteristics valid from 0°C to +45°C.

**Line Voltage Ranges** — 100 V, 110 V, 120 V, 200 V, 220 V, and 240 V ac ±10% (except that maximum input should not exceed 250 V ac). Internally selected with quick change jumpers.

**Line Frequency Range** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 110 W.

**External Intensity Input** — +5 V turns beam on from off condition. −5 V turns beam off from on condition. Frequency range dc to 1 MHz. Input R and C is ≈10 kΩ paralleled by ≈40 pF. Maximum input ±50 V (dc + peak ac.)

**Calibrator** — Voltage output 400 mV within 1%. Current output (loop) 4 mA within 1%. Frequency is 2 times line frequency.

**Beam Finder** — Positions beam on screen regardless of vertical and horizontal position control settings.

### OPTION 07
### REAR PANEL SIGNAL OUTPUTS

**Left and Center Compartments** — Two BNC connectors provide access to the CRT related signals from the left and center plug-in amplifiers. Sensitivity: 0.5 V/CRT division. Output Impedance: 1 kΩ.

**Right Compartment** — Sweep: One BNC connector provides access to the CRT-related sweep waveform. Sensitivity is 0.5 V/CRT division; positive-going sawtooth, ≥5 V. Output Impedance: 1 kΩ. Gate: One BNC connector provides access to TTL compatible gate. Positive-going, coincident with displayed sweep.

**X-Y Mode** — CRT related X-Y signals are available at the appropriate rear panel connectors when amplifier plug-ins are used in either the left or center compartment and the right compartment to display X-Y information. Sensitivity (X-Y): 0.5 V/CRT division.

**Dimensions and Weights** — See page 275.

### INCLUDED ACCESSORIES

Power cord (161-0066-00); instruction manual.

## ORDERING INFORMATION

**(PLUG-INS NOT INCLUDED)**

**5116** Oscilloscope ..... **$2,360**

**Option 02** — Protective Panel Cover (Cabinet Models Only). The cover protects the front panel and knobs during transportation and storage ..... **+$38**

**Option 07** — Add Rear Panel Signals Out (Both Models) ..... **+$125**

### CONVERSION KITS

**Cabinet-to-Rackmount Conversion Kit** Order 040-0583-03 ..... **$155**

**Rackmount-to-Cabinet Conversion Kit** Order 040-0584-04 ..... **$180**

**Protective Panel Cover Kit** Order 040-0620-00 ..... **$38**

**Rear Panel Signal Outputs Conversion Kit (Option 07)** Order 040-0915-02 ..... **$230**

### INTERNATIONAL POWER CORDS AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

**Option A5** — Switzerland 220 V/10 A, 50 Hz

**For 5D10 Waveform Digitizer see next page.**

**For recommended cameras refer to page 421.**

**For a description of color display technology, refer to the reference section beginning on page 17.**

**See this color product in the reference section beginning on page 23.**

# 5D10

**Compatible with all 5000 Series Mainframes**

**Digital Storage**

**CRT Readout**

**Powerful Triggering Capability**

**1% Accuracy**

**Dual Channel**

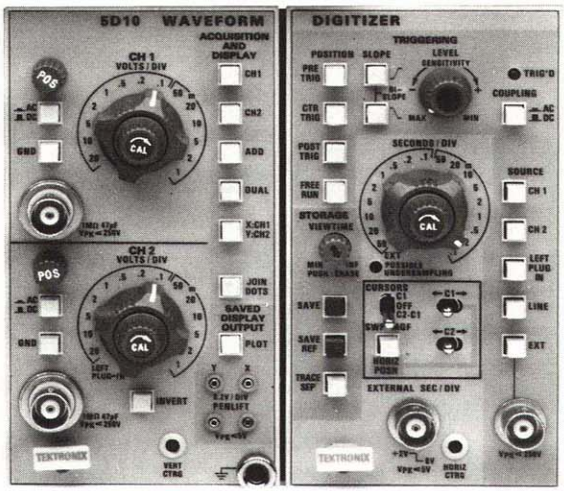
**1 MHz Sample Frequency**

**Save Reference Waveforms**

**X-Y Recorder Output**

**Signal Conditioning Via Left Vertical Plug-In**

**Color Signal Source for 5116 Oscilloscope**



*5D10 and 5A26 installed in a 5110 mainframe*

The 5D10 enhances all Tektronix 5000 Series mainframes by providing storage for transient events with frequency components up to 100 kHz for a single channel acquisition and up to 50 kHz for dual channel acquisition, all in a compact two-wide plug-in.

Together, the 5D10 and the Tektronix 5116 Oscilloscope create a system of high resolution color*[1] and waveform digitizing for superior trace and readout clarity.

The digital storage characteristics of the high performance 5D10 duplicate CRT storage features and provide the following additional features:

**Digital Storage**
Provides clear, crisp, bright displays which can be viewed indefinitely.

**Cursors**
Permit convenient single-point and point-to-point measurement of time, amplitude, and frequency for fast, accurate, and reliable answers.

**CRT Readout**
Displays all pertinent instrument settings, cursors, and waveform levels. Lets you read out complete operational status at a glance.

**Pretrigger**
Allows viewing information prior to the trigger event so you can see all your data. Center and posttrigger selection is also provided.

**Free Run**
Optimizes the data presentation for low speed phenomena, much like a stripchart recorder.

**1% Accuracy**
Improves measurement quality in both vertical and horizontal modes.

**Dual Samplers**
Ensures time coincidence between the two input channels.

**Bi-Slope Triggering**
Assures triggering when the slope of a transient event is not known.

**[1] Three-color display requires a 5D10 with serial number B020000 or higher. A field installable kit is available to upgrade earlier 5D10's. Contact your local Tektronix representative for details.*

**1 MHz Sample Frequency**
Stores single-shot events to approximately 100 kHz in bandwidth with 8-bit vertical resolution.

**Storage View-Time**
Convenient view time control from 1 second to infinity.

**Save Reference**
Permits comparisons of signals stored at different times.

**X-Y Displays**
Provides less than 1° phase shift up to 100 kHz of parametric related signals.

**X-Y Recorder Output**
Provides inexpensive, archivable hard copies complete with readout, graticule, and displayed waveforms in full color.

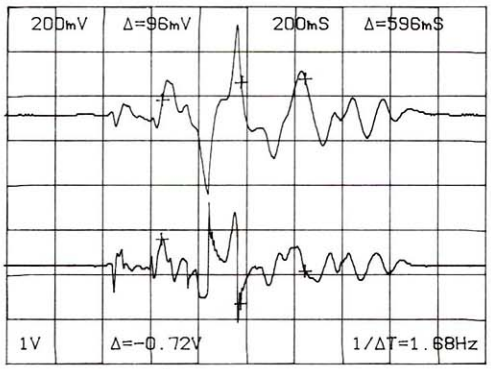
**Left Vertical Plug-in**
May be used to precondition up to two signals for Channel 2 of the 5D10 (when used in 5100 Series mainframes only).

For example, plug-ins such as the 5A21N, 5A22N and 5A26 can provide differential performance with sensitivities ranging to 10 μV/div (5A22N). The 5D10 can acquire a total of three signal channels when using the Channel 2 left plug-in acquisition feature.

## CHARACTERISTICS

### VERTICAL

**Vertical Modes** — CH 1, CH 2, Add, Dual, X-Y.
**Channel 2 Modes** — V/div, Left plug in.
**Deflection Factor** — 1 mV/div to 20 V/div in 14 calibrated steps (1-2-5 sequence).
**Accuracy** — Input to Readout Numbers: 5 mV/div to 1 V/div ±1%; 1 mV/div to 2 mV/div ±2%; 2 V/div to 20 V/div ±2%; Input to CRT graticule ±2%. From Left Vertical Plug-in: Add ±1% to above specifications. Add Mode: Add ±1% to above specifications.
**Input R and C** — 1 MΩ ±0.5% paralled by ≈47 pF.
**Maximum Input** — 250 V (dc + peak ac); 250 V p-p ac at 1 kHz or less.
**Bandwidth** — Single Channel: Suitable from dc to 100 kHz. Dual Channel: Suitable from dc to 50 kHz. Ac Coupling: 3 dB point—10 Hz or less (1 Hz with 10X probe).
**Common-Mode Rejection** — At least 50:1, dc to 100 kHz.
**Resolution** — Vertical: X-Y or Y-T; 0.04 div (8-bit digitzer). Horizontal: Y-T; 0.01 div (1024 memory locations shared among all traces displayed).
**Phase Shift** — ≤1.0° phase shift between CH 1 and CH 2, dc to 100 kHz.




*Example of plotter waveforms with graticule scaling information*

**Display Output (to X-Y Recorder)** — Amplitude: 0.2 V/div ±2%. Speed: Compatible with X-Y recorders with 20 in/s slew rate, or faster. Pen Lift: Isolated switch contacts, SPST (floating); normally open or normally closed selected by internal jumper.

### TIME BASE

**Sweep Rates** — 0.1 ms to 50 s/div in 18 calibrated steps 1-2-5 sequence.
**Accuracy** — Within ±1% of readout numbers.
**External Input** — Allows external pulse generator to determine acquisition rate. Accepts TTL levels up to 1 MHz rate.
**Possible Under-Sampling Indicator** — Indicator lights when fewer than eight sample pulses occur during interval between successive threshold crossing of triggering signals.

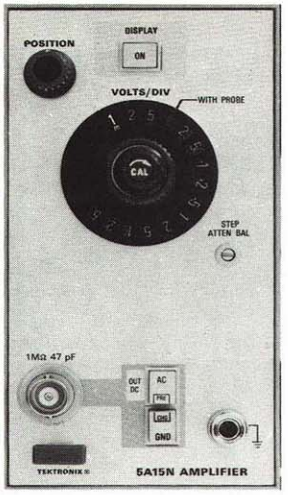
### TRIGGERING

**Sources** — CH 1, CH 2, left plug-in (via mainframe), line, external.
**Coupling** — Dc, ac.
**Sensitivity** — External: 100 mV; dc to 50 kHz or pulsewidth >5 μs; 250 mV 50 kHz to 250 kHz or pulsewidth >1 μs. CH 1, CH 2, Left Plug-in: 0.4 div, dc to 50 kHz or pulsewidth >5 μs; 1.0 div, 50 kHz to 250 kHz or pulsewidth >1 μs.
**Bi-Slope Trigger** — Amplitude, frequency, and pulsewidth specifications apply to absolute value of signal (rectified).
**External Trigger Input** — Input R and C: 1 MΩ ±2% paralleled by ≈47 pF. Maximum input 250 V (dc + peak ac). 250 V p-p ac at 1 kHz or less.
**Included Accessory** — Instruction manual.

## ORDERING INFORMATION

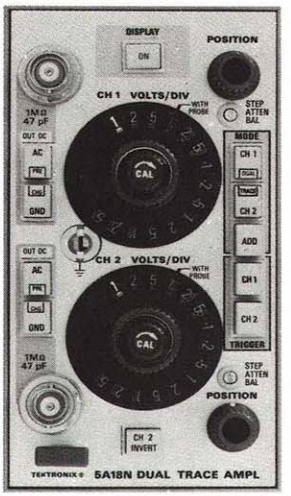
**5D10** Waveform Digitizer ..... **$1,995**

**5A15N**



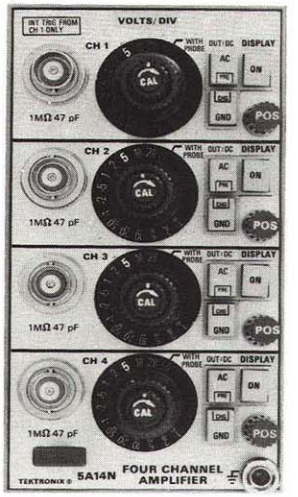

**Single Trace**

**5A18N**




**Dual Trace**

**5A14N**




**Four Trace**

## 5A15N Amplifier

### Dc to 2 MHz Bandwidth

### 1 mV/div to 5 V/div

The 5A15N is the simplest of the 5A Series plug-in amplifiers to use. It provides a bandwidth of dc to 2 MHz in any 5000 Series mainframe at sensitivities from 1 mV/div. Two 5A15Ns may be used in a mainframe to provide dual-trace operation, or to provide 1 mV/div X-Y operation if one of the amplifiers is inserted in the right-hand compartment of mainframe.

#### CHARACTERISTICS

**Bandwidth** — Dc Coupled: Dc to at least 1 MHz at all deflection factors. Ac Coupled: 2 Hz or less to at least 2 MHz at all deflection factors.

**Deflection Factor** — Calibrated: 1 mV/div to 5 V/div in 12 steps (1-2-5 sequence). Accuracy: Within 2%. Uncalibrated: Continuously variable between calibrated steps and to 12.5 V/div.

**Input R and C** — 1 MΩ within 1% paralleled by ≈47 pF.

**Maximum Input** — Dc Coupled: 350 V (dc + peak ac). Ac Coupled: 350 V dc.

**Included Accessory** — Instruction manual.

#### ORDERING INFORMATION

**5A15N** Amplifier ..... **$370**

## 5A18N Amplifier

### Dc to 2 MHz Bandwidth

### 1 mV/div to 5 V/div

The 5A18 is essentially a dual-trace 5A15N. Bandwidth is dc to 2 MHz in any 5000 Series mainframe at sensitivities to 1 mV/div. The Channel 2 signal may be inverted by means of a front panel switch to provide difference measurements of two signals in the ADD mode. The internal trigger signal is selectable from Channel 1 or Channel 2 by means of front-panel pushbuttons.

#### CHARACTERISTICS

**Bandwidth** — Dc Coupled: dc to at least 2 MHz at all deflection factors. Ac Coupled: 2 Hz or less to at least 2 MHz at all deflection factors.

**Deflection Factor** — Calibrated: 1 mV/div to 5 V/div in 12 steps (1-2-5 sequence). Accuracy: Within 2%. Uncalibrated: Continuously variable between calibrated steps and to 12.5 V/div.

**Input R and C** — 1 MΩ within 1% paralleled by ≈47 pF.

**Maximum Input** — Dc Coupled: 350 V (dc + peak ac). Ac-Coupled: 350 V dc.

**Chopping Rate** — 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

**Included Accessory** — Instruction manual.

#### ORDERING INFORMATION

**5A18N** Amplifier ..... **$765**

## 5A14N Amplifier

### Dc to 1 MHz Bandwidth

### 1 mV/div to 5 V/div

The 5A14N is a four-trace amplifier unit which provides 1 MHz bandwidth and sensitivity to 1 mV/div in any 5000 Series mainframe. Each channel may be displayed separately, or the channels may be alternated or chopped in any combination. The internal triggering signal is available from Channel 1 only. Two 5A14Ns may be combined to provide eight-trace operation in any 5000 Series mainframe.

#### CHARACTERISTICS

**Bandwidth** — Dc Coupled: Dc to at least 1 MHz at all deflection factors. Ac Coupled: 2 Hz or less to at least 1 MHz at all deflection factors.

**Deflection Factor** — Calibrated: 1 mV/div to 5 V/div in 12 steps (1-2-5 sequence). Accuracy: Within 2%. Uncalibrated: Continuously variable between calibrated steps and 12.5 V/div.

**Input R and C** — 1 MΩ within 1% paralleled by ≈47 pF.

**Maximum Input** — Dc Coupled: 350 V (dc + peak ac). Ac Coupled: 350 V dc.

**Chopping Rate** — 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

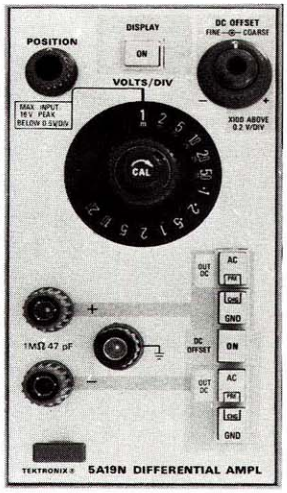
**Included Accessory** — Instruction manual.

#### ORDERING INFORMATION

**5A14N** Four Trace Amplifier ..... **$1,540**

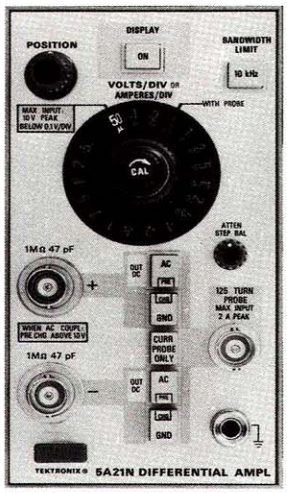
For recommended probes refer to pages 275 and 440.

**5A19N**




**Differential Amplifier**

**5A21N**




**Differential Amplifier**

## 5A19N

**Dc to 2 MHz Bandwidth**

**1 mV/div to 20 V/div**

**Dc Offset**

The 5A19N is a low-cost differential amplifier featuring variable dc offset and simplicity of controls. It is ideal for monitor and systems applications. It operates in the left or middle plug-in compartment of the 5000 Series mainframe for Y-T displays, or in the right compartment for X-Y displays.

### CHARACTERISTICS

**Bandwidth** — Dc Coupled: dc to at least 2 MHz at all deflection factors. Ac Coupled: 2 Hz or less to at least 2 MHz at all deflection factors.
**Deflection Factor** — Calibrated: 1 mV/div to 20 V/div in a 1-2-5 sequence. Accuracy: Within 2%. Uncalibrated: Continuously variable between calibrated steps and to 50 V/div.
**Input R and C** — 1 MΩ within 0.3% paralleled by ≈47 pF.
**Signal and Offset Range**

| Deflection Factor Settings | 1 mV/div to 200 mV/div | 500 mV/div to 20 V/div |
|---|---|---|
| Common-Mode Signal Range | ±16 V | ±350 V |
| Maximum Dc Coupled Input (Dc + Peak Ac at 1 kHz or Less) | ±350 V | |
| Maximum Ac Coupled Input (Ac Voltage) | ±350 V | |
| Dc Off Set Range | +15 V to −15 V | +350 V to −350 V |

**Common-Mode Rejection Ratio** — Dc Coupled: 1 mV/div to 200 mV/div, at least 1000:1 from dc to 10 kHz; decreasing to 100:1 at 500 mV/div to 20 V/div.
**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**5A19N** Differential Amplifier ..... **$455**

## 5A21N

**Dc to 1 MHz Bandwidth**

**10 kHz Bandwidth Limiter**

**50 μV/div to 5 V/div**

**100,000:1 CMRR**

**Voltage and Current Probe Inputs**

The 5A21N is a differential amplifier unit with a current probe input added. In the voltage mode, it provides a sensitivities of 50 μV/div to 5 V/div; with the optional P6021 Current Probe, it provides current sensitivities from 0.5 mA/div to 0.5 A/div. Bandwidth in the voltage mode is dc to 1 MHz; band width in the current mode is 15 Hz to 1 MHz. Bandwidth may be limited to 10 kHz to reduce displayed noise in lower-frequency applications. This feature can also be used to obtain a clean triggering signal from an excessively noisy signal.

The 5A21N operates in the left or middle plug-in compartment of the 5000 Series mainframe for Y-T displays, or in the right compartment for X-Y displays.

### CHARACTERISTICS

**Bandwidth** — Dc Coupled: dc to at least 1 MHz. Ac Coupled: 2 Hz less at least 1 MHz. Bandwidth may be limited to 10 kHz.
**Deflection Factor** — Calibrated: 50 μV/div to 5 V/div in 16 steps (1-2-5 sequence). Accuracy: Within 2%. Uncalibrated: Continuously variable between steps and to 12.5 V/div.
**Input R and C** — Voltage Mode: 1 MΩ within 0.15% paralleled by ≈47 pF.
**Maximum Input Voltage**

| | Dc Coupled | Ac Coupled |
|---|---|---|
| 50 μV/div to 50 mV/div | 10 V (dc + peak ac) | 350 V dc (coupling cap precharged), 10 V peak ac |
| 10 mV/div to 5 V/div | 350 V (dc + peak ac) | |

**Input Gate Current** — 100 pA or less (equivalent to 100 μV or less, depending on external loading, at +25°C.
**Displayed Noise** — 30 μV or less, tangentially measured.
**Common-Mode Rejection Ratio** — Ac Coupled: 50 μV/div to 0.5 mV/div, at least 20,000:1 at 5 kHz and above decreasing to 400:1 at 10 Hz. Dc Coupled: at least 100,000:1 dc to 30 kHz at 50 μV/div and 100 μV/div with up to 20 V p-p sinewave, decreasing by <20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, CMRR is at least 400:1 with up to 100 V p-p sinewave.

**CURRENT PROBE INPUT (with P6021 CURRENT PROBE)**
**Bandwidth** — 15 Hz or less, to at least 1 MHz. Bandwidth may be limited to 10 kHz.
**Deflection Factor** — Calibrated: 0.5 mA/div to 0.5 A/div in 10 steps (1-2-5 sequence). Accuracy: Within 3%. Uncalibrated: Continuously variable between steps and to 1.25 A/div.
**Maximum Input Current** — 4 A p-p (at probe loop) with 125-turn P6021 Current Probe.
**Displayed Noise** — 300 μA or less, tangentially measured. Performance characteristics are valid for the 5A21N from 0°C to +50°C.
**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**5A21N** Differential Amplifier ..... **$575**
**Option 01** — (Includes P6021, 5 ft current probe) ..... **+$300**

The 5A21N and 5A22N Differential Amplifiers are available with CRT readout at additional cost (CRT readout functional in 5400 Series mainframes only). Contact your local Tektronix Sales Engineer for details.

## P6055 20,000:1 CMRR 10X with Readout

**High CMRR**

**Compact Size**

**Low Capacitance**

**Dc to 60 MHz**

The P6055 is a miniature, low-capacitance, 10X probe designed for use with Tektronix differential amplifiers with nominal input capacitances from 20 pF to 47 pF. The attenuation ratio is adjustable to compensate for differences in input resistance of the amplifier (the amplifier input resistance must be 1 MΩ ± 2%). A special locking type readout connector allows the probe to be used with instruments with or without readout capability.
When two P6055 Probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other is helpful in maintaining the CMRR of the system. The use of a matched pair of P6055 differential probes provide the best possible system CMRR.

### CHARACTERISTICS

**CMRR** — 20,000:1 from dc to 1 kHz derating to 100:1 at 20 MHz. **Attenuation** — Adjustable to 10X. **Input Resistance** — 1 MΩ ±0.5%. **Input Capacitance** — ≈10 pF when used with instrument that has 20 pF input capacitance; 12.5 pF when used with instrument that has 47 pF input capacitance. **Maximum Useful Bandwidth** — 60 MHz. **Typical Probe Risetime** — 5.8 ns. **Maximum Voltage** — 500 V (dc + peak ac) from dc to 12 MHz. P-p voltage derates to 100 V at 70 MHz.

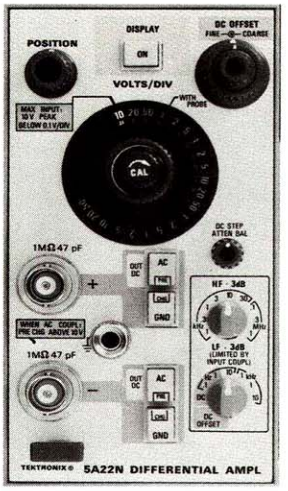
**INCLUDED ACCESSORIES**
Retractable hook tip (BB, 013-0107-03); 13 cm (5 inch) ground lead (175-0124-01); probe holder (352-0090-00); two electrical insulating sleeves (BP, 166-0404-01); two alligator clips (AS, 344-0046-00); adjustable tool (CP, 003-0675-01); hook tip (BU, 206-0114-00); 13 cm (6 inch) electrical ground lead (DF, 175-1256-00); 30 cm (12 inch) ground lead (175-0125-01); instruction manual.

### ORDERING INFORMATION

**P6055** 10X, 3.5 ft, Differential Probe. Order 010-6055-01 ..... **$275**
**Matched Pair** of P6055 Probes. Order 015-0437-00 ..... **$485**

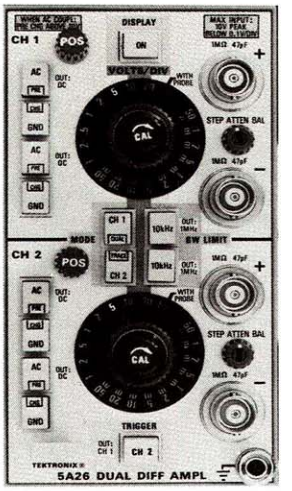
For recommended probes refer to pages 275 and 440.

**5A22N**




**Differential Amplifier**

**5A26**




**Dual Differential Amplifier**

**5CT1N**

**Curve Tracer**

## 5A22N

**Dc to 1 MHz Bandwidth**

**10 μV/div to 5 V/div**

**100,000:1 CMRR**

**Selectable Upper and Lower −3 dB Points**

**Dc Offset**

The 5A22N is the most versatile of the 5000 Series differential amplifiers. It features front panel selectable filtering which enables reduction of undesirable displayed noise; both upper and lower 3 dB points are selectable. Dc offset at full bandwidth is available for viewing signals riding on a dc component, such as low-level ripple and noise on a power supply.

These features, together with its high common-mode rejection, make the 5A22N well suited for measurements in difficult low-amplitude, low-frequency areas.

The 5A22N operates in all 5000 Series mainframes.

### CHARACTERISTICS

**Bandwidth** — HF −3 dB Point: Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz. 100 Hz to 0.3 MHz, accurate to within 20% of selected frequency; at 1 MHz, bandwidth is down 3 dB or less. LF −3 dB Point: Selectable in 6 steps (1-10 sequence) from 0.1 Hz to 10 kHz accurate to within 20% of selected frequency. Ac Coupled: 2 Hz or less.

**Deflection Factor** — Calibrated: 10 μV/div to 5 V/div in a 1-2-5 sequence. Accuracy: Within 3%. Uncalibrated: Continuously variable between steps and to at least 12.5 V/div.

**Common-Mode Rejection Ratio** — Ac Coupled: 10 μV/div to 0.5 mV/div, at least 20,000:1 at 5 kHz and above, decreasing to 400:1 at 10 Hz. Dc Coupled: at least 100,000:1, dc to 30 kHz from 10 μV/div to 100 μV/div with up to 20 V p-p sinewave, decreasing by <20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, CMRR is at least 400:1 with up to 100 V p-p sinewave.

**Signal and Offset Range**

| | | |
|---|---|---|
| Deflection Factor Settings | 10 μV to 50 mV/div | 0.1 V to 5 V/div |
| Common-Mode Signal Range | ±10 V | −350 V |
| Max Dc Coupled Input (Dc + Peak Ac at 1 kHz or Less) | ±12 V | ±350 V |
| Max Ac Coupled Input (Dc Voltage) | ±350 V Dc rejection, at least 4 x $10^5$:1 | |
| Dc Offset Range | +0.5 V to −0.5 V | +50 V to −50 V |

**Input R and C** — 1 MΩ within 0.15% paralleled by ≈47 pF.

**Overdrive Recovery** — 10 μs or less to recover within 99.5% of reference level after removal of a test signal applied for 1 s. Signal amplitude not to exceed common-mode signal range.

**Maximum Input Gate Current** — 200 pA or less.

**Displayed Noise** — 20 μV at maximum bandwidth, source resistance 25 Ω or less, measured tangentially.

**Drift with Temperature** — 100 μV/°C or less.

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**5A22N** Differential Amplifier ..... **$1,135**

The 5A21N and 5A22N Differential Amplifiers are available with CRT readout at additional cost (CRT readout functional in 5400 Series mainframes only). Contact your local Tektronix Sales Engineer for details.

## 5A26

**2 Differential Amplifiers in One Plug-In**

**50 μV/div Sensitivity at 1 MHz**

**100,000: 1 CMRR**

**CRT Readout**

The 5A26 Dual Differential Amplifier combines two independent differential amplifiers in one plug-in. It adds no-compromise differential measurement capability to the line of low-cost, high-performance 5000 Series laboratory oscilloscopes. It may be used in any 5000 Series mainframe.

For recommended probes refer to page 275 and 440.

The 5A26 provides 50 μV/div sensitivity at 1 MHz, high common-mode rejection ratio, ***CRT readout in any standard 5400 Series mainframe,*** trigger-source selection and bandwidth limit on each channel. With two 5A26s, it is possible to observe up to four differential channels at one time in the chop or alternate mode.

The 5A26 has many applications in areas that require dual differential performance, especially in biomedical and electromechanical fields, education, and component manufacturing.

### CHARACTERISTICS

**Number of Differential Channels** — Two.

**Bandwidth** — Dc Coupled: Dc to at least 1 MHz. Ac Coupled: 2 Hz or less to at least 1 MHz. Bandwidth may be limited to 10 kHz.

**Deflection Factor** — Calibrated: 50 μV/div to 5 V/div in 16 steps (1-2-5 sequence). Accuracy: Within 2%. Uncalibrated: Continuously variable between calibrated steps and to 12.5 V/div.

**CRT Readout** — CRT readout of deflection factors. Functional in CRT readout-equipped 5400 Series oscilloscopes, nonfunctional in 5100 Series oscilloscopes.

**Input R and C** — 1 MΩ within 0.15% paralleled by ≈47 pF.

**MAXIMUM INPUT VOLTAGE**

| | Dc Coupled | Ac Coupled |
|---|---|---|
| 50 μV/div to 50 mV/div | 10 V (dc + peak ac) | 10 V ac, 350 V (coupling cap precharged) |
| 100 mV/div to 5 V/div | 350 V (dc + peak ac) | 350 V (dc + peak ac) |

**Input Gate Current** — 100 pA or less (equivalent to 100 μV or less, depending on external loading) at +25°C.

**Displayed Noise** — 30 μV or less, tangentially measured.

**COMMON-MODE REJECTION RATIO**

| | |
|---|---|
| Dc Coupled | |
| 50 μV/div to 50 mV/div | At least 100,000:1 from dc to 30 kHz with up to 20 V p-p sinewave |
| 100 mV/div to 5 V/div | At least 300:1 from dc to 30 kHz with up to 100 V p-p sinewave |
| Ac Coupled | |
| 50 μV/div to 50 mV/div | At least 20,000:1 at 5 kHz to 30 kHz, decreasing to not less than 2000:1 at 60 Hz |

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**5A26** Dual Differential Amplifier ..... **$1,240**

**High CMRR Differential Probes**
Matched pair of P6055 probes for maximum CMRR described on previous page.

## 5CT1N Curve Tracer

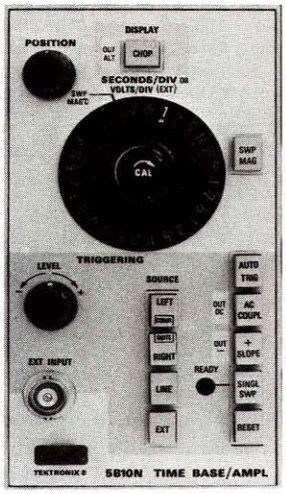
**Test Semiconductor Devices to 0.5 W**

**10 nA/div to 20 mA/div Vertical Deflection Factors**

**0.5 V/div to 20 V/div Horizontal Deflection Factors**

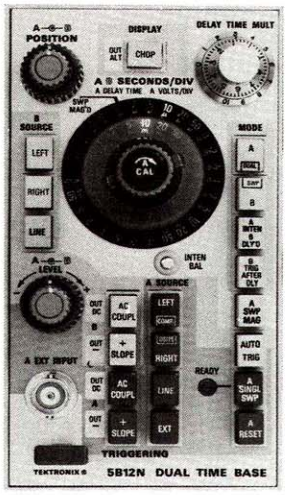
For a complete description see page 410.

**5B10N**



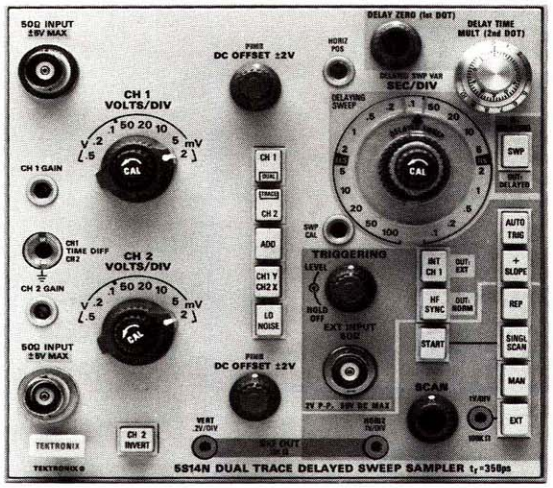

**Single Sweep Time Base**

**5B12N**




**Dual Sweep Time Base**

**5S14N**




**Sampler**

## 5B10N/5B12N

**100 ns/div to 5 s/div Calibrated Time Base**

**Single Sweep**

**X10 Magnifier**

**Provides Alternate and Chopped Displays**

**50 mV/div and 500 mV/div External Input**

**Dual and Delayed Sweep (5B12N)**

The 5B10N is a time base/amplifier plug-in unit for generating a sweep in the 5000 Series oscilloscopes. An external input allows use of the 5B10N as a voltage amplifier with calibrated deflection factors of 50 mV/div and 500 mV/div.

Multiple triggering modes may be pushbutton selected with the 5B10N. Source positions include left or right plug-in, composite (from the mainframe vertical amplifier), line and external.

The 5B12N is a time base for generating single, dual, or delayed sweeps in 5000 Series oscilloscopes. The 5B12N is normally used in the right plug-in compartment but is compatible with the vertical deflection compartments as well.

The 5B12N display modes are A sweep, B sweep, A intensified–B delayed, and dual sweep. Each mode is selectable by pushbutton switches. Triggering sources for A and B sweep include left and right plug-in, line, and display composite. In the display composite mode the sweep is triggered from the composite signal being displayed. Auto and external trigger and single sweep are provided for the A sweep. The B sweep operates in triggered or free-run mode after the delay time.

When operated in the dual-sweep mode in a dual-beam oscilloscope with two amplifier plug-ins, first the A sweep and then the B sweep displays the signals from both amplifiers; four traces will be displayed. Both sweeps are displayed simultaneously in chop mode.

When operated in the dual-sweep mode in a single-beam oscilloscope with two amplifier plug-ins, the A sweep is slaved to the left plug-in and the B sweep is slaved to the right plug-in.

The display mode pushbutton selects chop or alternate time-share switching between vertical plug-ins and amplifier channels. Chop rate is 25 kHz to 100 kHz depending on plug-in combinations and number of traces displayed.

### CHARACTERISTICS

The following specifications are the same for the 5B10N and the A sweep of the 5B12N. B sweep specifications are identical except where indicated.

**Sweep Rates** — Calibrated: 1 μs/div to 5 s/div in 21 steps (1-2-5 sequence). X10 Magnifier extends displayed sweep time/div to 100 ns. Uncalibrated: Continuously variable between steps and to 12.5 s/div. B Sweep: 0.2 μs/div to 0.5 s/div in 20 calibrated steps.

**Sweep Accuracy** — Unmagnified: Within 3% from 1 μs/div to 1 s/div and within 4% of 2 s/div and 5 s/div. Magnified displays accurate within 1% in addition to specified time base sweep accuracy. B Sweep: Within 3% from 1 μs/div to 0.1 s/div. Within 4% at 0.2 μs/div, and 0.5 s/div, 0.2 s/div, and 0.5 s/div.

**Triggering Sensitivity**

| | Coupling | To 1 MHz | At 2 MHz |
|---|---|---|---|
| Dc | Internal | 0.4 div | 0.6 div |
| | External*1 | 200 mV | 200 mV |
| Ac | Requirements increase below 50 Hz | | |

*1 *Does not apply to B sweep.*

**Auto Trig** — Same as above except signal rate requirements are 15 Hz and above.

**Single Sweep** — Same as for ac and dc coupled.*1

**External Trigger Input** — Maximum Input: 350 V (dc + peak ac). Input R and C: 1 MΩ within 2% paralleled by ≈70 pF. Trigger Level Voltage Range: +5 V to −5 V*1.

*1 *Applies to A trigger only.*

**EXTERNAL HORIZONTAL MODE**

**Deflection Factor** — Calibrated: 50 mV/div and 500 mV/div. Accuracy: Within 3%. X10 variable extends range to at least 5 V/div.

**Bandwidth** — Dc Coupled: Dc to at least 1 MHz. Ac Coupled: 50 Hz or less to at least 1 MHz.

**Input R and C** — 1 MΩ within 2% paralleled by ≈70 pF.

**Maximum Input Voltage** — 350 V (dc + peak ac).

**DELAYING SWEEP (5B12N)**

**Delay Time** — Accuracy: 1 μs/div to 0.5 s/div, within 1%. 1 s/div to 5 s/div, within 2%. Multiplier Range: 0.2 to 10.2 times the time/div setting. Multiplier Incremental Linearity: Within 0.2%.

**Differential Time Measurement Accuracy** — Within 1% plus 2 minor dial div for 1 μs to 0.5 s delay times. Within 2% plus 2 minor dial div for 1 s to 5 s delay times.

**Jitter** — <0.05% of the time represented by one division of the delaying sweep selected.

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**5B10N** Time Base/Amplifier ..... **$555**

**5B12N** Dual Time Base ..... **$1,170**

## 5S14N

**Dc to 1 GHz Bandwidth**

**Dual Trace, 2 mV/div Sensitivity**

**Calibrated Delayed Sweep**

**Simplified Triggering**

**Operational Ease of Conventional Oscilloscope**

**Two-Dot Time Measurements**

The 5S14N Sampling Unit combines amplifier and time-base functions in one double-width plug-in unit designed to operate in all 5000 Series mainframes. Combining the sampling amplifier and time-base functions in one plug-in enables the 5S14N to provide economy and ease of operation. See page 272 for complete description.

### CHARACTERISTICS

**AMPLIFIER**

**Bandwidth** — Dc to 1 GHz.
**Risetime** — 350 ps or less.
**Deflection Factor** — Calibrated: 2 mV/div to 0.5 V/div in 8 steps (1-2-5 sequence). Uncalibrated: Variable between steps by at least 2.5 to 1.
**Maximum Input Voltage** — ±5 V.
**Input Signal Range** — 2 V p-p maximum within a +2 V to −2 V window at any sensitivity.
**Dc Offset Range** — At least +2 V to −2 V.

**TIME BASE**

**Scan Modes** — Repetitive, Single, Manual, or External.
**Horizontal Signal Output** — 1.0 V/div of horizontal deflection; 10 kΩ source resistance.

**DELAYING SWEEP**

**Range** — 10 ns/div to 100 μs/div in 13 steps (1-2-5 sequence).
**Delay Accuracy** — Within ±1% of 10 div when measurement is made within the last 9.5 div.

**DELAYED SWEEP**

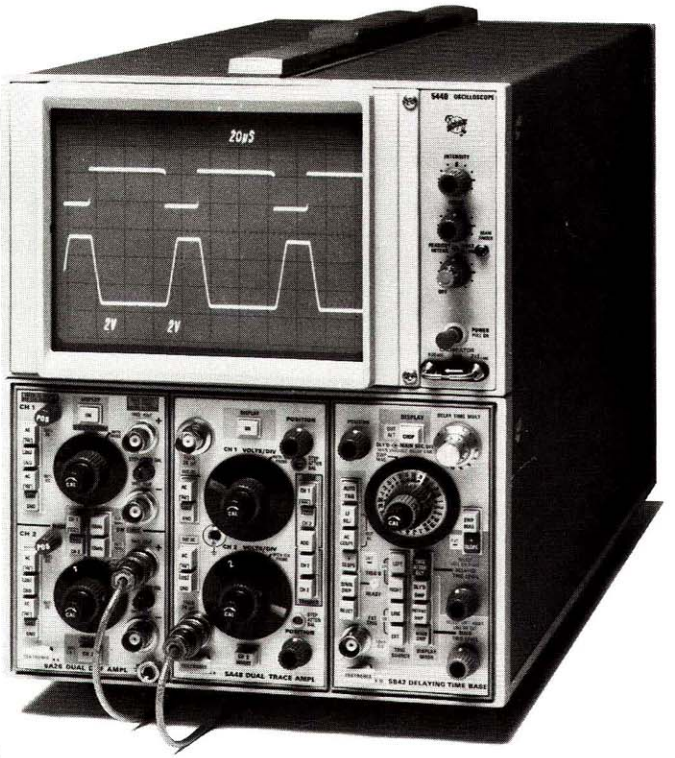
**Range** — 100 ps/div to 100 μs/div in 19 calibrated steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.
**Delay Jitter** — <0.05% of the time represented by 1 div of the Delaying Sweep selected.

**TRIGGERING AND SYNC**

**Signal Source** — Interval from CH 1 vertical input or external through front-panel connector.
**External Triggering** — Nominal 50 Ω input, ac coupled, 2 V p-p, 50 V dc maximum. Trigger pulse amplitude 10 mV p-p or more with risetime of 1 μs or less. 10 Hz to 100 MHz. Sinewave amplitude 10 mV p-p or more from 150 kHz to 100 MHz.
**Internal Triggering** — Pulse amplitude 50 mV p-p or more with risetime of 1 μs or less. Sinewave amplitude 50 mV p-p or more from 150 kHz to 100 MHz.

### ORDERING INFORMATION

**5S14N** Sampler ..... **$5,920**



## 5440/R5440

**Dc to 50 MHz**

**Sampling to 1 GHz**

**CRT Readout**

**3 Plug-in Flexibility**

**Wide Choice of Plug-ins**

**Bench to Rack Convertibility**

## TYPICAL APPLICATIONS

- **Electrical Engineering**
- **Component Testing**
- **Ultrasonics**

The 5440 combines versatility and low cost in a 50 MHz general-purpose, plug-in oscilloscope. It features CRT readout of plug-in scale factors, a three plug-in mainframe, a wide choice of plug-ins*[1] and bench to rack convertibility.

CRT readout displays plug-in scale factors on the CRT, so measurement time and operator errors are reduced by taking into account magnifiers and probe attenuators. It can also be accessed externally. This unique ability can be used to read out dates, picture numbers, digital clock times, etc (with Option 03 User Addressable CRT Readout).

All the plug-ins in the 5000 Series are compatible with the 5440.*[2]

The wide variety of plug-ins available lets you configure your oscilloscope to meet your needs today as well as tomorrow: from a single-trace, single time-base configuration for production monitoring, to four-trace, delayed sweep for logic work, to four-trace differential amplifiers for transducer measurements, to dual-trace, delayed sweep for general purpose measurements.

If you're looking for a general-purpose oscilloscope, the 5440 gives you the most versatility and performance at the lowest price.

*[1] Plug-ins with a suffix N (5B12N, etc.) do not provide CRT readout.*

*[2] The 5B10N and 5B12N Time Bases do not permit viewing the leading edge of a triggered waveform when used in the 5400 Series.*

## CHARACTERISTICS

### VERTICAL SYSTEM

**Channels** — Left and center plug-in compartments are compatible with all 5000 Series plug-ins. CRT readout is not available with plug-ins having a suffix N (5A18N, etc.).

**Deflection Factor** — Determined by plug-in unit.

**Bandwidth** — 50 MHz, determined by plug-in unit.

**Chopped Mode** — The 5440 will chop between channels at ≈25 kHz to 100 kHz, depending on plug-ins and operating modes.

**Alternate Mode** — Each amplifier plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before the 5440 switches to the second amplifier.

### HORIZONTAL SYSTEM

**Channel** — Right-hand plug-in compartment compatible with all 5000 Series plug-ins. CRT readout is not available for plug-ins with a Suffix N (5B10N, etc.).

**Internal Trigger Mode** — Left vertical, center vertical.

**Fastest Calibrated Sweep Rate** — 10 ns/div, determined by plug-in.

**X-Y Mode** — Phase shift within 2° from dc to 20 kHz.

### CRT AND DISPLAY FEATURES

**CRT** — Internal parallax-free 8 x 10 div (1.22 cm/div) graticule with edge-lit illumination.

**Phosphor** — GH (P31) standard, GM (P7) or BE (P11) optional.

**Accelerating Potential** — 15 kV.

**External Intensity Input** — +5 V turns beam on from off condition. −5 V turns beam off from on condition. Frequency range dc to 2 MHz. Input R and C is ≈10 kΩ paralleled by ≈40 pF. Maximum input is ±50 V (dc + peak ac).

### OTHER CHARACTERISTICS

**Calibrator** — Voltage amplitude is 400 mV within 1%. Current is 4 mA within 1%. Frequency is two times the line frequency.

**Minimum Photographic Writing Speed** — Using Polaroid film 20,000 ASA without film fogging. Writing speed can be increased with the Tektronix Writing Speed Enhancer (see camera section for more information).

| Writing Speed cm/μs | | | | Camera | Lens |
|---|---|---|---|---|---|
| GH (P31) Phosphor | | BE (P11) Phosphor | | | |
| 20,000 ASA | 3000 ASA | 20,000 ASA | 3000 ASA | | |
| 180 | 90 | 245 | 125 | C-59P | f/2.8 0.67 mag |
| 330 | 160 | 450 | 230 | C-50P*1*2 | f/1.9 0.7 mag |

*[1] Slight cropping of the graticule corners.*

*[2] Requires optional battery pack (016-0270-02) for operation with the 5440.*

**Beam Finder** — Intensifies trace and brings it into graticule areas.

**Ambient Temperature** — Performance characteristics valid from 0°C to +50°C unless otherwise specified.

**Line Voltage Range** — 100, 110, 120, 200, 220, and 240 V ac ±10%; (Except that maximum input should not exceed 250 V ac) internally selected with quick change jumpers. Line frequency range, 48 Hz to 440 Hz.

**Maximum Power Consumption** — 100 W at 120 V ac, 60 Hz.

**Dimensions and Weights** — See page 275.

**Included Accessory** — Instruction manual.

## ORDERING INFORMATION

**(PLUG-INS NOT INCLUDED)**

The 5440 may be ordered as a cabinet-model oscilloscope equipped with a tilt bail, or as a 5.25 inch rackmount oscilloscope with slide-out assembly.

**5440** Oscilloscope ..... **$2,955**

**R5440** Oscilloscope (Rackmount) ..... **$3,020**

**Option 01** — Without CRT Readout. The 5440 may be ordered without CRT readout. This feature can easily be added later with a conversion kit ..... **−$325**

**Option 03** — User Addressable CRT Readout. Additional CRT readout access is available for programming two 10-digit characters such as time, operator name, or test number. The additional display is useful for photographic records and is programmed by external resistors and switches ..... **+$125**

**Option 04** — Protective Panel Cover (Cabinet Model Only). The 5440 may be ordered with a protective front-panel cover to protect the front panel and knobs during transportation and storage ..... **+$38**

**Option 76** — GM (P7) Phosphor ..... **+$50**

**Option 78** — BE (P11) Phosphor ..... **+$50**

### CONVERSION KITS

**Cabinet-to-Rackmount** — Order 040-0583-03 ..... **$155**

**Rackmount-to-Cabinet** — Order 040-0584-04 ..... **$180**

**CRT Readout** — Order 040-0691-02 ..... **$550**

### INTERNATIONAL POWER CORDS AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

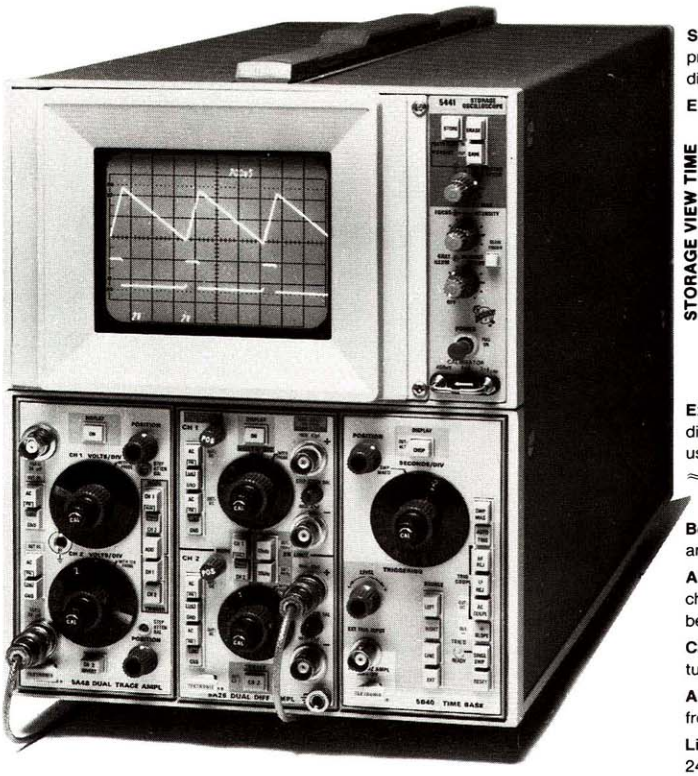
**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

**For recommended cameras refer to page 421.**

## 5441/R5441

- Low Cost
- Variable Persistence Storage
- CRT Readout
- Dc to 50 MHz
- Sampling to 1 GHz
- Three Plug-in Flexibility
- Wide Choice of Plug-ins
- Bench to Rack Convertibility
- 5 div/μs Stored Writing Speed



## TYPICAL APPLICATIONS

- **Ultrasonics**
- **Low Power Laser**
- **Fiber Optics**

With the 5441 Variable Persistence Storage Oscilloscope, view time at normal intensity can be varied from a fraction of a second to more than five minutes. In the save mode, signals can be viewed at lower intensity for up to an hour.

High-speed events that occur only once or at very low repetition rates are easily observed. You can make low frequency measurements more easily and accurately by eliminating flicker or transforming a slowly moving dot into a stable display. Repetitions of the same signal can be compared simultaneously to detect changes in amplitude or phase. The integrating effect of variable persistence can be used to suppress the random noise that obscures low signal-to-noise ratio waveforms.

The 5441 enhances the capabilities of the 5000 Series sampler plug-in. In sampling applications, discrete dot traces are converted into a continuous waveform by holding repeated sweeps on the CRT.

Like other 5400 Series oscilloscopes, the 5441 offers CRT readout of deflection factors for convenient, error-free measurements and optional user-programmable CRT readout of test information for ready identification and easy photographic recording. With the flexibility of a three plug-in mainframe and a wide choice of plug-ins, you can make virtually any measurement from dc to 50 MHz.

## CHARACTERISTICS

### VERTICAL SYSTEM

**Channels** — Left and center plug-in compartments compatible with all 5000 Series plug-ins. CRT readout not available for plug-ins with suffix N (5A18N, etc.).

**Deflection Factor** — Determined by plug-in.

**Bandwidth** — 50 MHz, determined by plug-in.

**Chopped Mode** — The 5441 will chop between channels at ≈25 kHz to 100 kHz, depending on plug-ins and operating modes.

**Alternate Mode** — Each plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before the 5441 switches to the second amplifier.

### HORIZONTAL SYSTEM

**Channel** — Right-hand plug-in compartment compatible with all 5000 Series plug-ins. CRT readout not available for plug-ins with suffix N (5B10N, etc.).

**Internal Trigger Mode** — Left vertical, right vertical.

**Fastest Calibrated Sweep Rate** — 10 ns/div, determined by plug-in.

**X-Y Mode** — Phase shift within 2° from dc to 20 kHz.

### CRT AND DISPLAY FEATURES

**CRT** — Internal, parallax-free, 8 x 10 div (0.9 cm/div) graticule with edge-lit illumination.

**Persistence** — Continuously variable, may be turned off when not needed, thus producing high-contrast stored displays without the characteristic fading of variable persistence.

**Phosphor** — GH (P31) is standard.

**Accelerating Potential** — 8.5 kV.

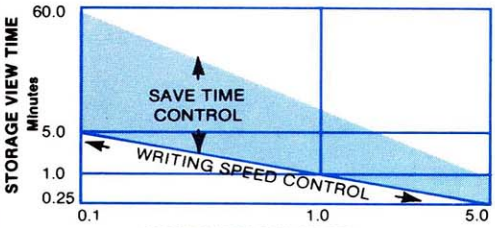
**Maximum Stored Writing Speed** — Writing speed >5 div/μs for a view time of 15 s.

**Storage View Time** — The view time is the amount of time the stored signal can be viewed before it fades away.

At the maximum writing speed the view time is 15 seconds with the writing speed control fully cw. Adjusting the stored intensity ccw will reduce the stored writing speed, but view time can be increased up to 5 minutes (refer to chart next column).

**Save Mode** — Extends view time of stored displays up to 1 hr; prevents erasure of stored display and storage of unwanted displays.

**Erase Time** — 0.5 s ±10%.




**External Intensity Input** — +5 V turns beam on from off condition. −5 V turns beam off from on condition. Dc to 2 MHz usable frequency range. Input R and C ≈10 kΩ paralleled by ≈40 pF. Maximum input 50 V (dc + peak ac).

### OTHER CHARACTERISTICS

**Beam Finder** — Intensifies trace and brings it into graticule area.

**Auto Focus** — Reduces the need for manual focusing with changes in intensity after the front-panel Focus control has been set.

**Calibrator** — Voltage amplitude 400 mV ±1%. Current amplitude 4 mA ±1%. Frequency is 2 times line frequency.

**Ambient Temperature** — Performance characteristics valid from 0°C to +50°C unless otherwise specified.

**Line Voltage Ranges** — 100, 110, 120, 200, 220, and 240 V ac ±10%; (except that maximum input should not exceed 250 V ac) internally selected with quick change jumpers. Line frequency range, 48 Hz to 440 Hz.

**Maximum Power Consumption** — 100 W at 120 V ac, 60 Hz.

**Dimensions and Weights** — See page 275.

**Included Accessory** — Instruction manual.

## ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

**5441** Oscilloscope ..... **$5,010**

**R5441** Oscilloscope (Rackmount) ..... **$5,060**

**Option 01** — Without CRT Readout. The 5441 may be ordered without CRT readout. This feature can easily be added later with a conversion kit ..... **−$350**

**Option 03** — User Addressable CRT Readout. CRT readout access allows the operator to program up to two 10-digit words ..... **+$125**

**Option 04** — Protective Panel Cover (Cabinet Model Only). The 5441 may be ordered with a protective front-panel cover to protect the front panel and knobs during transportation and storage ..... **+$38**

### CONVERSION KITS

**Cabinet-to-Rackmount** — Order 040-0583-03 ..... **$155**

**Rackmount-to-Cabinet** — Order 040-0584-04 ..... **$180**

**CRT Readout** — Order 040-0691-02 ..... **$550**

### INTERNATIONAL POWER CORDS AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

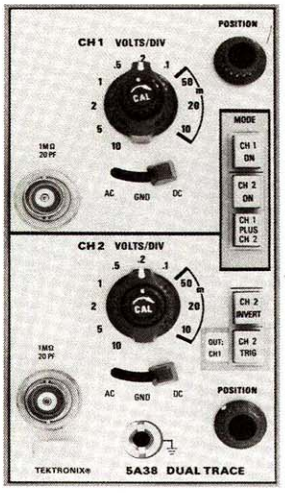
**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

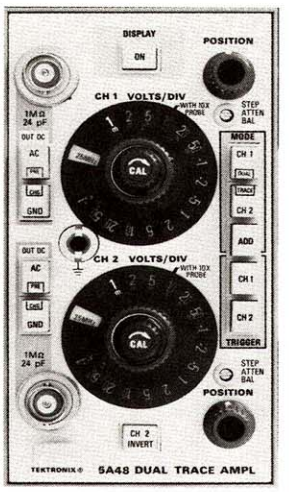
**For recommended cameras refer to page 421.**

**5A38**



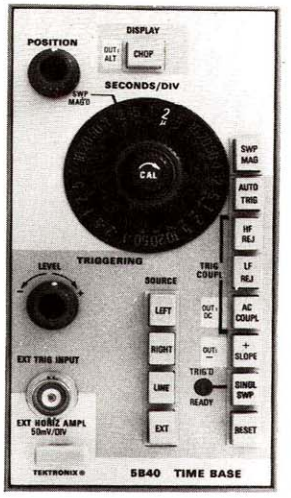

Dual Trace

**5A48**



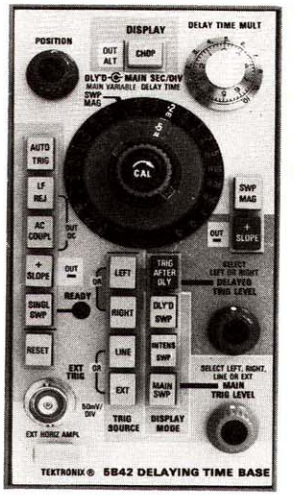

Dual Trace

**5B40**




Time Base

**5B42**




Delaying Time Base

## 5A38 Dual-Trace Amplifier

### Dc to 35 MHz Bandwidth

### Low Cost

### 10 mV/div to 10 V/div Calibrated Deflection Factors

The 5A38 is a dual-trace, 35 MHz plug-in amplifier for use only in the 5223 and the 5400 Series mainframes. It features 10 mV/div sensitivity and CRT readout of deflection factor.*1

### CHARACTERISTICS

**Bandwidth** — Dc Coupled: To ⩾35 MHz. Lower End Response, Ac Coupled: ⩽10 Hz.
**Display Modes** — Channel 1 only, Channel 2 only (normal or inverted), Dual-Trace, and Added. Alternated or chopped operation determined by time base plug-in. Internal trigger selectable from Channel 1 or Channel 2.
**Risetime** — ⩽10 ns.
**Deflection Factors** — Calibrated: 10 mV/div to 10 V/div in a 1-2-5 sequence. Accuracy: ⩽3% from 15°C to 35°C, 4% from 0°C to +50°C. Uncalibrated: Continuously variable control provides ⩾2.5X additional attenuation on each range.
**Channel Isolation** — ⩾50:1 to 35 MHz with both traces displayed.
**Input R and C** — 1 MΩ paralleled by ≈20 pF.
**Maximum Input Voltage** — Dc Coupled: 250 V (dc + peak ac). Ac Coupled: 500 V (dc + peak ac). Ac Component: 500 V p-p maximum at 1 kHz or less.
**Stability** — ⩽0.3 mV vertical shift in any one minute after 1 hr warm-up, ambient temperature and line voltage held constant. ⩽0.2 mV/°C vertical shift with line voltage held constant.
**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**5A38** Dual-Trace Amplifier ..... **$720**
For floating measurements, order A6902A Isolator. See page 434 for complete description.

*1 CRT readout not functional in 5223.

## 5A48 Dual-Trace Amplifier

### Dc to 50 MHz Bandwidth

### 1 mV/div to 10 V/div Calibrated Deflection Factors

The 5A48 is a dual-trace 50 MHz plug-in amplifier for use only in the 5223 and the 5400 Series mainframes. The 5A48 features five operating modes, selectable trigger source, and CRT readout of deflection factor.*1

### CHARACTERISTICS

**Bandwidth** — Dc Coupled: Dc to at least 50 MHz at 5 mV/div to 10 V/div, decreasing to dc to 25 MHz at 1 mV/div and 2 mV/div (3 dB down). Ac Coupled: 10 Hz or less (1.0 Hz with a 10X probe) at all deflection factors (3 dB down).
**Display Modes** — Channel 1 only, Channel 2 only (normal or inverted), Dual-trace, Added, Alternated, Chopped (determined by time-base plug-in horizontal compartment). Internal Trigger Source: Selectable from Channel 1 or Channel 2.
**Risetime** — 7 ns or less (5 mV/div to 10 V/div), 14 ns or less (1 mV/div and 2 mV/div).
**Deflection Factors** — Calibrated: 1 mV/div to 10 V/div in a 1-2-5 sequence. Accuracy: ⩽5% at 1 mV/div and 2 mV/div; ⩽3% from 5 mV/div to 10 V/div from +15°C to +35°C; ⩽4% from 5 mV/div to 10 V/div from 0°C to +50°C. Uncalibrated: Continuously variable control provides ⩾2.5X additonal attenuation on each range.
**Input R and C** — 1 MΩ within 1% paralleled by ≈24 pF.
**Maximum Input Voltage** — Dc Coupled: 250 V (dc + peak ac. Ac Coupled: 500 V (dc + peak ac). Ac Component: 500 V p-p maximum, 1 kHz or less.
**Stability** — ⩽0.3 mV vertical shift in any one minute after one hour warm-up, ambient temperature and line voltage held constant. ⩽0.2 mV/°C vertical shift with line voltage held constant.
**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**5A48** Dual-Trace Amplifier ..... **$1,065**
For floating measurements, order A6902A Isolator. See page 434 for complete description.

*1 CRT readout not functional in 5223.

## 5B40/5B42 Time Bases

### Single Sweep

### 10 ns/div to 5 s/div Calibrated Time Base

### Triggering to 50 MHz

The 5B40/5B42 Time Bases are designed for use in 5400 Series mainframes. They feature sweep rates from 10 ns/div to 5 s/div and CRT readout of the sweep rate selected. The 5B42 also features delayed sweep rates up to 10 ns/div.

### CHARACTERISTICS

The following characteristics are the same for the 5B40 and 5B42 unless otherwise noted.
**Sweep Rate** — 0.1 μs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 10 ns/div is fastest sweep rate obtained with X10 magnifier. Uncalibrated, continuously variable between steps and up to 12.5 s/div.
**Sweep Accuracy** — Measured in 5400 Series oscilloscope over center 8 graticule divs. Valid for 100 div of magnified sweep after the first 30 ns.

| Time/Div | Unmagnified | | Magnified | |
|---|---|---|---|---|
| | +15°C to +35°C | 0°C to +50°C | +15°C to +35°C | 0°C to +50°C |
| 1 s/div to 0.5 μs/div | 3% | 4% | 4% | 5.5% |
| 5 s/div and 2 s/div, 0.2 μs/div and 0.1 μs/div | 4% | 5% | 5% | 6.5% |

**Triggering Sensitivity**

| Coupling | Frequency Range | Minimum Signal Required | |
|---|---|---|---|
| | | Internal | External |
| Dc 5400 ampl | Dc to 10 MHz | 0.4 div*1 | 60 mV*1 |
| | | 0.4 div*2 | 100 mV*2 |
| 5400 ampl | 10 MHz to 60 MHz | 1.0 div*1 | 150 mV*1 |
| | | 1.0 div*2 | 400 mV*2 |
| 5100 ampl | Dc to 2 MHz | 0.4 div*2 | 100 mV*2 |
| Ac | Trigger requirements increase below 50 Hz | | |
| LF Rej | Trigger requirements increase below 7.5 kHz | | |
| HF Rej | Trigger requirements increase above 50 kHz*1 | | |

*1 5B40 only. *2 5B42 only.

**Single Sweep** — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep.
**Ext Trigger Input** — Maximum input voltage: 350 V dc + peak ac, 350 V p-p ac at ⩽1 kHz. Input R and C: 1 MΩ paralleled by ≈24 pF. Trigger Level Range: ⩾ ±1.5 V (5B40) and ±2.5 V (5B42).
**Ext Horizontal Input** — Deflection Factor: 50 mV/div ±3%. Input R and C is 1 MΩ paralleled by ≈24 pF. Dc Coupled Bandwidth: Dc to ⩽2 MHz. Ac Coupled Lower Response: ⩽50 Hz. Maximum Input Voltage: 350 V (dc + peak ac) or 350 V p-p ac at ⩽1 kHz.

**DELAYING SWEEP (5B42 ONLY)**

**Delay Time Multiplier Range** — 0.2 to 10 times the Time/Div setting.
**Differential Time Measurement Accuracy** — Within 1% plus 0.2% of full scale from 1 μs to 0.5 s delay time. Within 2% plus 0.2% of full scale of 1 s to 5 s delay time.
**Jitter** — <0.05% of the time represented by 1 division of delaying sweep selected.

**DELAYED SWEEP (5B42 only)**

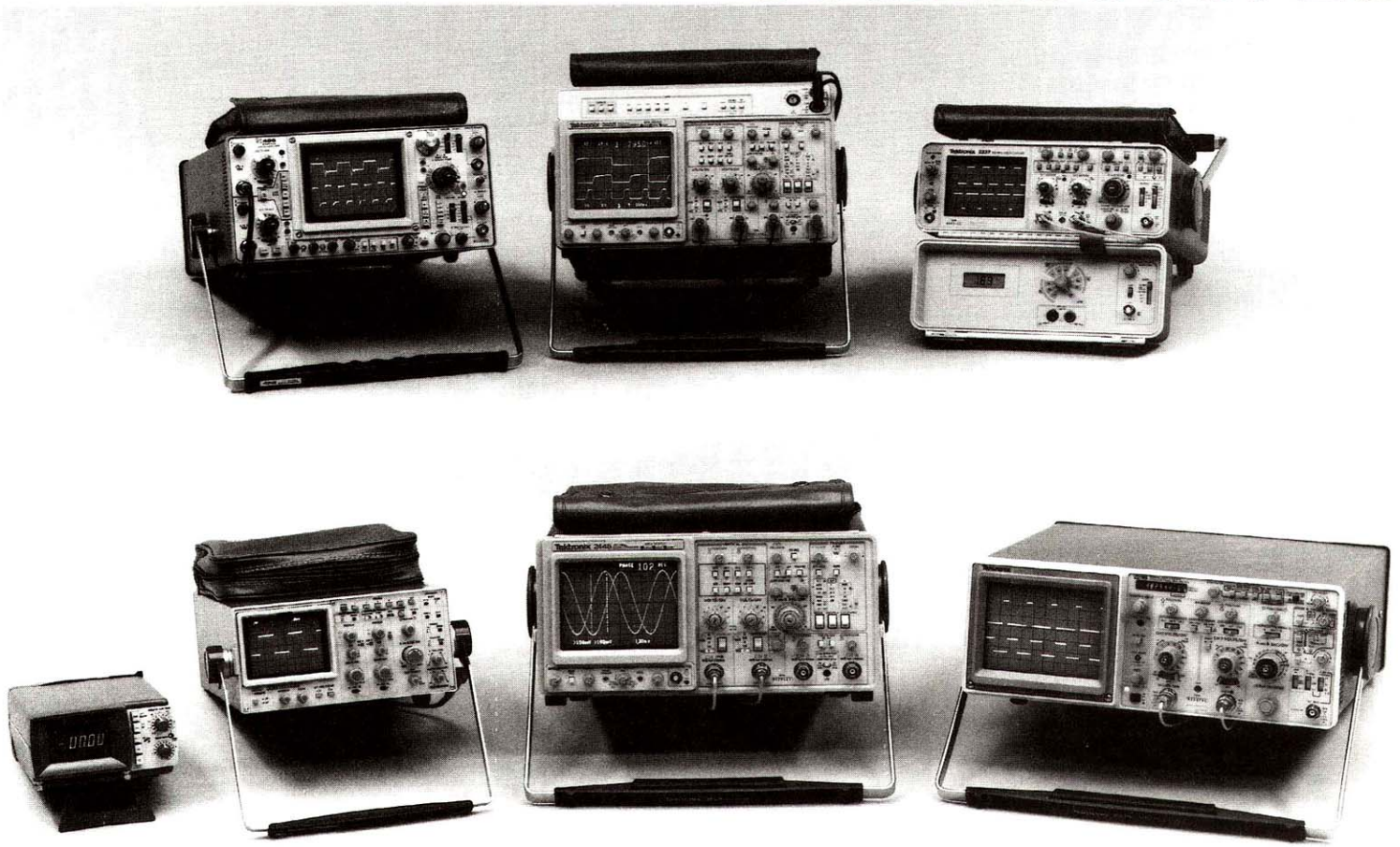
**Sweep Rate** — 0.1 μs/div to 0.5 s/div in 21 calibrated steps (1-2-5 sequence). 10 ns/div is the fastest calibrated sweep rate obtained with the X10 magnifier.
**Sweep Accuracy** — Measured over the center 8 division. Same as undelayed sweep.
**Triggering** — The same as the internal triggering specifications in the table above.
**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**5B40** Time Base ..... **$730**
**5B42** Delaying Time Base ..... **$1,345**

For recommended probes refer to pages 275 and 440.

# PORTABLE OSCILLOSCOPES



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**Tektronix offers the widest selection of portable scopes so you'll be able to choose the specific instrument that best suits your needs.**

27 portable scopes are available with bandwidths from 500 kHz to 350 MHz nonstorage or storage.

All Portable Oscilloscopes listed in this section are available through the National Marketing Center by calling toll free 1-800-426-2200. In addition to being able to give you direct order entry, the NMC Sales Engineers are available to offer you immediate technical assistance about product specifications, capabilities, and applications. They can send you literature, discuss available accessories, tell you about payment terms and options, or help you contact your local sales and service office.

## PORTABLE REAL TIME OSCILLOSCOPES COMPARISON CHART

| PRODUCT | BANDWIDTH (MHz) | SENSITIVITY (mV/div) | TRACE | DELAYED SWEEP | FASTEST SWEEP (ns/div) | FEATURES | SIZE mm (in) HxWxD | WEIGHT kg (lb) | POWER REQUIREMENTS | PAGE |
|---|---|---|---|---|---|---|---|---|---|---|
| 485 | 350*1 | 5 | Dual | yes | 1 | Widest BW in a portable instrument | 170x310x470 (7x12x19) | 9.5 (21) | Line (90-136/180-272 V ac, 48-440 Hz) | 290 |
| 2465*2<br>2465CTS*3<br>2465DMS*3<br>2465DVS*3 | 300 | 2 | 4 | yes | 500 ps | CRT Readout, ΔVolts<br>ΔTime Cursors | 190x330x434 (7.5x13x17.1) | 10.2 (22.4) | Line (90-132/180-250 V ac, 48-440 Hz) | 292 |
| 2445*2 | 150 | 2 | 4 | yes | 1 | CRT Readout, ΔVolts<br>ΔTime Cursors | 190x330x434 (7.5x13x17.1) | 10.2 (22.4) | Line (90-132/180-250 V ac, 48-440 Hz) | 292 |
| 2335 | 100 | 5 | Dual | yes | 5 | Rugged, compact lightweight | 140x270x430 (5x11x17) | 7.7 (17) | Line (100-132/200-250 V ac, 48-440 Hz) | 299 |
| 2336 | 100 | 5 | Dual | yes | 5 | B Trigger, ΔTime | 140x270x430 (5x11x17) | 7.7 (17) | Line (100-132/200-250 V ac, 48-440 Hz) | 299 |
| 2336YA | 100 | 5 | Dual | yes | 5 | B Trigger, ΔTime, Elapsed Time Indicator, Extra probes and manual | 140x270x430 (5x11x17) | 7.7 (17) | Line (100-132/200-250 V ac, 48-440 Hz) | 299 |
| 2337 | 100 | 5 | Dual | yes | 5 | B Trigger, ΔTime, DMM | 140x270x430 (5x11x17) | 7.7 (17) | Line (100-132/100-250 V ac, 48-440 Hz) | 299 |
| 2235<br>2235Opt 01 | 100*4 | 2 | Dual | yes | 5 | Dual Time Base, Single Sweep Trigger View, BW Limit | 137x360x440 (5.4x14.2x17.3) | 6.1<br>13.5 | Line (90-250 V ac, 48-440 Hz) | 303 |
| 2236 | 100*4 | 2 | Dual | yes | 5 | Dual Time Base, BW Limit with Counter, Timer, Multimeter | 137x360x440 (5.4x14.2x17.3) | 7.4 (16.3) | Line (90-250 V ac, 48-440 Hz) | 303 |
| 2213A | 60*5 | 2 | Dual | yes | 5 | Low Cost Delayed Sweep, BW Limit | 137x360x440 (5.4x14.2x17.3) | 5.8 (12.8) | Line (90-250 V ac, 48-440 Hz) | 307 |
| 2215A | 60*5 | 2 | Dual | yes | 5 | Dual Time Base, BW Limit, Single Sweep | 137x360x440 (5.4x14.2x17.3) | 6.1 (13.5) | Line (90-250 V ac, 48-440 Hz) | 307 |
| 305 | 5 | 5 | Dual | no | 100 | Autoranging DMM battery power | 110x240x370 (4.4x9x15) | 4.8 (10.6) | Line (90-132/180-264 V ac, 48-440 Hz) built-in battery, or external dc | 309 |
| 221 | 5 | 5 | Single | no | 100 | 5 MHz hand-held | 80x130x230 (3x5x9) | 1.6 (3.5) | Built-in battery,line (90-250 V ac, 48-62 Hz) | 310 |
| 213 | 1 | 20 | Single | no | 400 | DMM/scope at <4 lb (1.7 kg) | 70x130x230 (3x5x9) | 1.7 (3.7) | Built-in battery, line (90-136/180-250 V ac, 48-62 Hz), or external dc | 311 |
| 212 | 0.5 (500 kHz) | 10 | Dual | no | 1000 (1 μs/div) | Integral 1 MΩ probe | 80x130x240 (3x5x10) | 1.6 (3.5) | Built-in, battery, line (104-126 V ac 58-62 Hz) | 312 |

## PORTABLE STORAGE OSCILLOSCOPES COMPARISON CHART

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 468 | 100 | 5 | Dual | yes | 2 | GPIB Interface option<br>10 MHz Stored Writing Speed*6 | 160x330x550 (6x13x22) | 12.7 (28) | Line (90-132/198-250 V ac 48-440 Hz) | 330 |
| 466 | 100 | 5 | Dual | yes | 5 | Two storage modes and reduced scan<br>3000 div/μs Stored Writing Speed | 160x330x550 (6x13x22) | 11.8 (26) | Line (99-132/198-264 V ac, 48-440 Hz) or battery pack | 314 |
| 464 | 100 | 5 | Dual | yes | 5 | Two storage modes<br>110 div/μs Stored Writing Speed | 160x330x550 (6x13x22) | 11.8 (26) | Line (99-132/198-264 V ac 48-440 Hz) or battery pack | 314 |
| 336 | 50 | 5 | Dual | yes | 100 | Digital Storage 1 Ms/s Microprocessor control and Menu driven*6 | 112x237x482 (4.4x9.3x14.6) | 11.3 | Line (90-132/180-250 V ac 48-440 Hz) | 332 |
| 434 | 25 | 10 | Dual | no | 20 | Split screen storage<br>5000 div/μs Stored Writing Speed | 140x330x480 (6x13x19) | 9.4 (20.7) | Line (99-136/180-272 V ac, 48-440 Hz) or external dc | 316 |
| 314 | 10 | 1 | Dual | no | 100 | Stored Viewing Time to 4 hr<br>400 div/ms Stored Writing Speed | 110x240x350 (4.4x9x14) | 4.7 (10.3) | Line (90-132/180/264 V ac, 48-440 Hz) or external dc | 317 |
| T912 | 10 | 2 | Dual | no | 50 | Low cost bistable storage<br>250 div/ms Stored Writing Speed | 250x180x480 (10x7x19) | 8.2 (18) | Line (90-132/198-250 V ac 50-60 Hz) | 319 |
| 214 | 0.5 (500 kHz) | 10 | Dual | no | 1000 (1 μs/div) | Fully self-contained<br>500 div/ms Stored Writing Speed | 80x130x240 (3x5x10) | 1.6 (3.5) | Built-in battery or line (104-126 V ac, 58-62 Hz) | 318 |

*1 *Bandwidth specifications for the 485 are dc to 350 MHz with 50 Ω inputs and dc to 250 MHz with 1 MΩ inputs.*
*2 *The 2445 and 2465 offer as options: 4½ digit DMM, 150 MHz Counter/Timer/Trigger, 17-Bit Word Recognizer, TV Trigger and GPIB Interface.*
*3 *Special Edition 2465.*
*4 *The 2235 and 2236 are specified 100 MHz for sensitivities from 5 mV to 5 V/div and 90 MHz in 2 mV.*
*5 *The 2213A and 2215A are specified 60 MHz for sensitivities from 5 mV to 5 V/div and 50 MHz in 2 mV.*
*6 *See specifications in digitizer section.*

## PORTABLE SCOPE APPLICATION LITERATURE

Tektronix product literature is readily available from your local Tektronix Sales office. Addresses and phone numbers are listed on pages 10 through 12 of this catalog. For data sheets and product brochures, just ask for literature on the specific instrument. Additional related publications also available are listed below.

| TITLE | FEATURING | PART NO |
|---|---|---|
| Portable Oscilloscope Selection Guide | A helpful aid for choosing the right portable scope for your needs | 38W-5158-1 |
| Miniature, Battery-Powered Scopes | Built to Tek's High-Performance Standards | 40W-5000-1 |
| 300 Series Portable Oscilloscopes | Brochure for the full line of SONY-TEKTRONIX mini-portable scopes | 40AX-3792-2 |
| 400 Series Portable CRT Storage Scopes | Descriptions of the 466, 464, and 434 portable storage scopes | 40W-3793-2 |
| T900 Series Data Sheet | Includes the popular T912 low cost storage scope. Request 2200 Series literature to supplement this data sheet | 41A-3933-3 |
| XYZs Of Using a Scope | A basic primer that features the 2200 Series | 46AX-4758-1 |
| Basic Oscilloscope Measurements: | Period and Frequency | 41AX-3839-1 |
| Basic Oscilloscope Measurements: | Amplitude | 41AX-3840-1 |
| Basic Oscilloscope Measurements: | Setup and Analysis | 41AX-3841-1 |
| Basic Oscilloscope Measurements: | Dual-Trace and X-Y Phase | 41AX-3928 |
| Basic Oscilloscope Measurements: | Rise Time | 41AX-3929 |
| Using Delayed Sweep In Measuring Digital Word Trains | Application Note | 41AX-3349 |
| VITS Analysis for TV Servicing | Application Note | 41AX-4047-1 |
| Troubleshooting Color TV Power Supplies | Application Note | 41AX-4048-1 |
| The Digital Storage Oscilloscope | A primer that describes digital storage concepts and the 468 | 40W-4319-2 |
| Variable Persistence Storage Applications | Application Note | 42AX-3198 |
| Bistable Storage Applications | Application Note | 42AX-3199 |
| Spotlight Hidden Pulses With High Speed Storage | Three-page application note that features the 466 | 40AX-3225 |
| 468 *BROADCAST ENGINEERING* Reprint | Making broadcast timing measurements with the 468 | 40AX-4483 |
| External Storage For The 468 Digital Storage Oscilloscope | Application note describes transferring waveforms captured with the 468 to external data storage devices | 40AX-4614 |
| Using The 468 in Envelope Mode | Application note on the 468 envelope mode for glitch-catching and babysitting applications | 40AX-4615 |
| 468 *COMPUTER DESIGN* Reprint | Dual sampling rates in the 468 envelope mode extends digital scope capabilities | 40AX-4838 |
| Your Direct Line to the World's Best Instruments and Technical Expertise | Find out about the Tektronix National Marketing Center and Tek's service offices | 60A-4873-1 |
| 2400 Series Oscilloscopes | Brochure describing the 2445 and 2465 scopes | 38W-5139-2 |
| Basic Video System Measuremens | Describes TV measurements using 2445/2465 Option 05 scopes | 38W-5708 |
| 2000 Series Warranty Brochure | Describes Tek's 3-year warranty on 2000 Series scopes and 5-year warranty plus service | 81W-5258 |
| 2300 Series Data Sheet | Includes the rugged and compact 2335, 2336, and 2337 | 40AX-4414-2 |
| Basic Video System Measurements | Describes TV measurements using 2445/2465 Option 05 scopes | 38W-5708 |
| 2400 Series Data Sheet | Includes 2445, 2465, 2465 DVS, 2465 CTS, 2465 DMS scopes and options; CTT, WR, TV, GPIB, DMM | 38W,5138-3 |

## PORTABLE SCOPE ACCESSORIES CHART

| | PROBES | | | CAMERAS | | | CART | MISCELLANEOUS ACCESSORIES |
|---|---|---|---|---|---|---|---|---|
| | Passive | Active | Current | Single Shot or Low Rep Rate | Stored/Stable or Repetitive | Low Cost | | |
| 485 | P6101 P6063B<br>P6106 P6015<br>P6056 P6009<br>P6057 P6048<br>P6122 P6130 | P6201<br>P6202A<br>P6230 | A6302/AM 503<br>A6303/AM 503 | C-31B<br>016-0306-01<br>adaptor*1 | C-30B<br>016-0306-01<br>adaptor*1 | NA | 200C | Folding Viewing Hood 016-0274-00 & 016-0082-00; 1105 Battery Power Supply Rain Cover 016-0554-00; Rack Adaptor 016-0558-00. |
| 468 | P6101 P6015<br>P6105 P6009<br>P6062B P6048<br>P6122 P6130 | P6201<br>P6202A<br>P6230 | P6022<br>A6302/AM 503<br>A6303/AM 503 | C-31B Opt 01<br>016-0269-03<br>adaptor*1 | C-30B Opt 01<br>016-0269-03<br>adaptor*1 | C-5C Opt 02 016-0359-01<br>adaptor*1<br>C-4 122-0894-01<br>adaptor*1 | 200C<br>Model 3 | Viewing Hood (Binocular) 016-0566-00; Folding Polarized Viewing Hood 016-0180-00; 1105 or 1106 Battery Power Supply Mesh Filter 378-0726-01; Rack Adaptor (468) 016-0675-00. |
| 465M | P6101 P6015<br>P6104 P6009<br>P6122 P6130 | P6201<br>P6202A<br>P6230 | P6022<br>A6302/AM 503<br>A6303/AM 503 | C-31B Opt 01<br>016-0269-03<br>adaptor*1 | C-30B Opt 01<br>016-0269-03<br>adaptor*1 | C-5C Opt 02 016-0359-01<br>adaptor*1<br>C-4 122-0894-01 adaptor*1 | 200C | Folding Polarized Viewing Hood 016-0180-00; Mesh Filter 378-0726-01; 1105 Battery Power Supply; Rack Adaptor 040-0825-01. |
| 466<br>464 | P6101 P6015<br>P6105 P6009<br>P6062B P6130<br>P6122 | P6201<br>P6202A<br>P6230 | P6022<br>A6302/AM 503<br>A6303/AM 503 | C-31B Opt 01<br>016-0269-03<br>adaptor*1 | C-30B Opt 01<br>016-0269-03<br>adaptor*1 | C-5C Opt 02 016-0359-01<br>adaptor*1<br>C-4 122-0894-01 adaptor*1<br>adaptor*1 | 200C | Folding Polarized Viewing Hood 016-0180-00; Collapsible Viewing Hood (Binocular) 016-0566-00; Protective Cover 016-0365-00; Mesh Filter 378-0726-01; 1105 Battery Power Supply; Rack Adaptor 016-0675-00. |
| 434 | P6101 P6015<br>P6108 P6122<br>P6009 P6105 | P6201<br>P6202A | P6021 P6022<br>A6302/AM 503<br>A6303/AM 503 | C-31B Opt 01<br>016-0269-03<br>adaptor*1 | C-30B Opt 01<br>016-0269-03<br>adaptor*1 | C-5C Opt 02 016-0359-01<br>adaptor*1 (handheld)<br>C-4 122-0894-01 adaptor*1 | 200C | Folding Polarized Viewing Hood 016-0180-00; Mesh Filter 378-0682-00; 1105 Battery Power Supply; Rack Adaptor 016-0272-00. |
| 2445<br>2465<br>2465 DVS<br>2465 CTS<br>2465 DMS | P6101 P6015<br>P6131 P6009<br>P6048 | P6201<br>P6202A<br>P6230 | P6022<br>A6302/AM 503<br>A6303/AM 503 | C-31B Opt 01<br>016-0269-03<br>adaptor*1 | C-30B Opt 01<br>016-0269-03<br>adaptor*1 | C-5C Opt 02 016-0359-01<br>adaptor*1<br>C-4 122-0894,01 adaptor*1 | 200C | Folding Polarized Viewing Hood 016-0180-00; Collapsible Viewing Hood (Binocular) 016-0566-00; 1105 Battery Power Supply; Protective Cover 016-0720-00. |
| 2335<br>2336<br>2336YA<br>2337 | P6063B P6130<br>P6108 P6009<br>P6101 P6015 | P6202A<br>P6201<br>P6230 | P6022<br>A6302/AM 503<br>A6303/AM 503 | NA | NA | C-5C Opt 04 016-0359-01<br>adaptor*1<br>(with flash) | NA | 2335 Rack Adaptor Kit 016-0468-00. |
| 2213A<br>2215A<br>2235<br>2235 Opt 01<br>2236 | P6101 P6009<br>P6122 P6015<br>P6121 (2236) | P6201<br>P6202A<br>P6230 | P6021 P6022<br>A6302/AM 503<br>A6303/AM 503 | | | C-5C Opt 04 016-0359-01<br>adaptor*1<br>(with flash) | 200C | Clear CRT Light Filter Custom Mod 108-2775-01; CRT TV Graticule Custom Mod 108-0175-00; Accessories Pouch 016-0677-00; Front Cover 200-2520-00; RM Kit: 016-0466-00 for 2213, 2215 and 2235; 016-0015-00 for 2236; P6602 Temperature Probe 010-6602-00. |
| 314, 305<br>335, 336 | P6101<br>P6149A | | P6021 P6022<br>A6302/AM 503<br>A6303/AM 503 | C-31B Opt 01<br>016-0327-01<br>adaptor*2 | C-30B Opt 01<br>016-0327-01<br>adaptor*2 | | NA | Viewing Hood 016-0297-00; Mesh Filter 378-0063-00; 1105 Battery Power Supply; Rain Cover (314, 335) 016-0612-00. |
| T912 | P6101 P6015<br>P6108 P6122<br>P6062B P6007 | | P6021 P6022<br>A6302/AM 503<br>A6303/AM 503 | | | C-5C Opt 03 016-0358-01<br>adaptor*1<br>(with flash) | NA | Protective Cover 016-0340-00; Dust/Rain Jacket 016-0361-00. |
| T922R | P6101 P6015<br>P6108 P6122<br>P6062B P6007 | | P6021 P6022<br>A6302/AM 503<br>A6303/AM 503 | C-31B Opt 01<br>016-0248-01<br>adaptor*2 | C-30B Opt 01<br>016-0248-01<br>adaptor*2 | C-5C Opt 01 016-0357-01<br>adaptor*1<br>C-4 Opt 02 122-0895-01<br>adaptor*1 | NA | Viewing Hood 016-0377-00. |

*1 *Mounting adaptor comes with camera/option listed, others are optional.* *2 *Mounting adaptor must be ordered in addition to the camera/option listed.*

## 485

**350 MHz at 5 mV/div**

**1 ns/div Sweep Rate**

**2.0 div/ns Writing Speed**

**1 MΩ & 50 Ω Input Impedances**

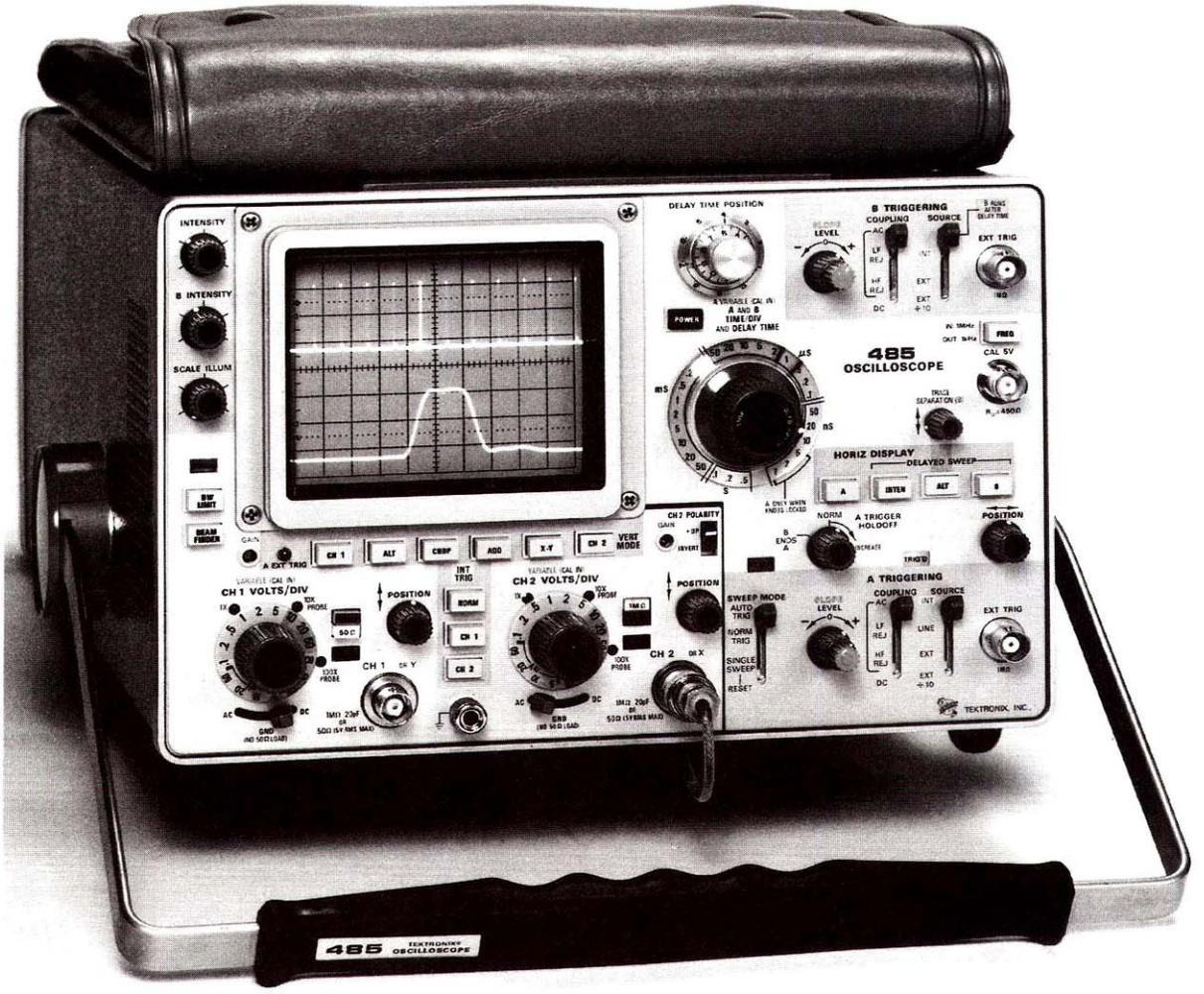
**Input Protection 50 Ω Internal**

**Automatic Deflection Factor Readout**

**Pushbutton Ext Trigger View**

**Battery Operation (Optional)**

**Weighs ≈9.5 kg (21 lb)**




At just 21 pounds, the 1 ns/div dual-trace 485 is the only true portable, 350 MHz oscilloscope on the market. This wide bandwidth is one reason why the 485 is highly compatible with today's increasing technology.

Many features contribute to the 485's extraordinary overall performance. Fast 2.0 div/ns writing speed is one, making it especially attractive for use in field research environments.

The 485 features a wide bandwidth at its full 5 mV/div vertical sensitivity (350 MHz at 50 Ω and 250 MHz at 1 MΩ). Selectable input impedance provides the capability to measure low and high impedance points with the same scope and without active probes.

Internal detection circuitry protects the 50 Ω input by automatically disconnecting when the signal exceeds approximately 5 V RMS.

You no longer have to mentally compensate for attenuating probes. Automatic vertical scale-factor readout is provided by three light-emitting diodes located around the edge of each input attenuator knob. A quick glance at the readout tells the operator the correct on-screen V/div when the recommended 10X or 100X probes are used.

You always know exactly where you are in a pulse train when making a delayed sweep measurement. An alternate sweep mode allows the delayed sweep to appear alternately with the intensified main sweep. In this mode, you can view the intensified zone and the delayed display simultaneously.

The external trigger signal can be easily viewed on the 485. A front-panel pushbutton automatically routes the external signal used to trigger time base A to the vertical deflection amplifier. This feature can also be used to quickly make time comparisons between the signal of interest and the external trigger signal.

On the 485, focus is always correct for single-shot photography. An autofocus circuit eliminates the need to readjust the focus each time the intensity is changed.

When commercial power is not available, use the 1105 Battery Power Supply. It weighs only 19.5 pounds, and lets you take the high-performance 485 virtually anywhere.

Often chosen as a general-purpose scope for computer and electronic servicing environments because of its fast writing speed and wide bandwidth, the 485 can also be found in specialized and unusual applications. For example, to maintain a groundbased laser/radar acquisition system, the 485's alternate sweep switching capability can be very useful.

## CHARACTERISTICS

### VERTICAL DEFLECTION
### (2 IDENTICAL CHANNELS)

**Bandwidth*1 and Risetime*2**

| | −15°C to +35°C | +35°C to +55°C |
|---|---|---|
| 50 Ω | Dc to 350 MHz, 1 ns | Dc to 300 MHz, 1.2 ns |
| 1 MΩ | Dc to 250 MHz, 1.41ns | Dc to 200 MHz, 1.8 ns |

*1 *Measured at −3 dB. Bandwidth may be limited to ≈20 MHz by bandwidth limit switch.*

*2 *At all deflection factors from 50 Ω terminated source.*

**Lower −3 dB Point, Ac Coupling** — 1X Probe: 1 kHz or less for 50 Ω, and 10 Hz or less for 1 MΩ. 10X Probe: 100 Hz or less for 50 Ω, and 1 Hz or less for 1 MΩ.

**Deflection Factor** — Calibrated: 5 mV/div to 5 V/div (1-2-5 sequence). Accuracy: +2%. Uncalibrated: Continuously variable between steps and to at least 12.5 V/div. Gain can be recalibrated at the front panel.

**Display Modes** — CH 1, CH 2 (normal and inverted), Alternate, Chopped (≈1 MHz rate), X-Y (CH 1-Y and CH 2-X), Add (CH 1 ± CH 2).

**Common-Mode Rejection Ratio** — At least 20 dB at 50 MHz for common-mode signals of 6 div or less.

**Automatic Scale Factor** — Probe tip deflection factors for 1X, 10X, and 100X coded probes are automatically indicated by three readout lights at the edge of the knob skirts. All lights are off when the channel is not selected for display or when the trace identification control on the probe is depressed.

**Selectable Input Impedance** — 50 Ω and 1 MΩ impedances are available at a single BNC connector by pushbutton selection. 50 Ω ±0.5%; VSWR 1.15:1 or less from 20 mV/div to 5 V/div, 1.25:1 or less at 5 mV/div and 10 mV/div to 350 MHz.

**Input R and C** — 1 MΩ ±1% paralleled by ≈20 pF.

**50 Ω Protection** — Internal detection circuitry provides protection by automatically disconnecting excessive signals of up to 50 V. The "disconnected" condition is indicated, and has manual reset.

**Maximum Input Voltage**

| | | |
|---|---|---|
| 50 Ω | Protection disconnect occurs for voltages that exceed approximately: 5 V RMS continuous 0.1 W-second for instantaneous voltages of 5 V to 50 V | |
| 1 MΩ | Dc coupled | 250 V (dc + peak ac), 500 V p-p to 1 kHz |
| | Ac coupled | 500 V (dc + peak ac) 500 V p-p to 1 kHz |

**Selectable Input Coupling** — Ac; dc; GND (provides zero reference, precharges coupling capacitor, disconnects 50 Ω load in 50 Ω mode).

**Delay Line** — Permits viewing leading edge of displayed waveform.

**Probe Power** — Connectors provide correct voltages for two optional P6201, P6202A or P6230 active probes.

### HORIZONTAL DEFLECTION

**Time Base A and B** — Calibrated Sweep Range: 1 ns/div to 0.5 s/div (1-2-5 sequence).

**Variable Time Control** — Time Base A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div.

**Time Base A and B Accuracy**[*1]

| Sweep Rate | +15°C to +35°C | −15°C to +55°C |
|---|---|---|
| 1 ns/div to 20 ns/div | ±3% | ±5% |
| 50 ns/div to 0.1 s/div | ±2% | ±4% |
| 0.2 s/div and 0.5 s/div | ±3% | ±5% |

*[*1] Center 8 division.*

**Horizontal Display Modes** — A, Intensified, Alternate, and B (delayed sweep). A only is displayed for A sweep rates of 1, 2, and 5 ns/div. B ends A for increased intensity in the delayed mode.

**Alternate Display Modes** — Allows the B delayed sweep to appear alternately with the intensified A sweep. Trace separation control positions B (delayed sweep ≈4 div from the A sweep).

### CALIBRATED SWEEP DELAY

**Delay Time Range** — 0 to 10X delay time/div setting of 10 ns/div to 0.5 s/div.

**Differential Delay Time Measurement Accuracy**

| Delay Time Setting | +15°C to +35°C |
|---|---|
| 10 ns/div and 20 ns/div | ±(1% of measurement +0.2% of full scale)*[1] |
| 50 ns/div to 1 ms/div | ±(0.5% of measurement +0.1% of full scale)*[1] |
| 2 ms/div to 0.5 s/div | ±(1% of measurement +0.1% of full scale)*[1] |

*[*1] Full scale is 10 times the delay time/div setting.*

**Jitter** — 1 part or less in 20,000 of 10X the time/div setting.

### TRIGGERING A and B

**A Trigger Modes** — Normal (sweep runs when triggered). Automatic (sweep free-runs in the absence of a triggering signal and for signals below 20 Hz). Single sweep (sweep runs one time on the first triggering event after the reset selector is pressed). Lights Indicate when sweep is triggered and when single sweep is ready.

**A Trigger Holdoff** — Adjustable control permits a stable presentation of repetitive complex waveforms. The control covers at least the time of one full sweep for faster than 0.2 s/div.

**B Trigger Modes** — B runs after delay time (starts automatically at the end of the delay time) and B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

**Time Base A and B Trigger Sensitivity and Coupling**

| Coupling | To 50 MHz | To 350 MHz |
|---|---|---|
| Dc Internal | 0.3 div deflection | 1.5 div deflection |
| Dc External | 20 mV | 100 mV |
| Ac | Signals below 16 Hz are attenuated | |
| Ac LF Reject | Signals below 16 kHz are attenuated | |
| Ac HF Reject | Signals below 16 Hz and above 50 kHz are attenuated | |

**Jitter** — 0.1 ns or less at 350 MHz at 1 ns/div.

**A Trigger View** — A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. This provides quick verification of the external signal and time comparison between a vertical signal and the external trigger signal. The deflection factor is ≈50 mV/div (0.5 V/div with external ÷ 10 source).

**Level and Slope** — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. External, level is adjustable through at least ±0.5 V for either polarity; ±5 V for external ÷ 10.

**A Sources** — Internal, line, external, external ÷ 10.

**B Sources** — B runs after delay time, internal, external, external ÷ 10.

**External Inputs** — R and C ≈1 MΩ paralleled by ≈20 pF. Maximum Input Voltage: 500 V (dc + peak ac), 500 V p-p to 1 kHz.

### X-Y OPERATION

**Full Sensitivity X-Y (CH 1 Vertical, CH 2 Horizontal)** — 5 mV/div to 5 V/div, accurate ±2%. Y-axis bandwidth identical to CH 1. X-axis bandwidth is dc to at least 4 MHz (−3 dB). Phase difference between amplifiers is 3° or less to 4 MHz.

### DISPLAY

**CRT** — 8 x 10 division display, each division is 0.8 cm. Horizontal and vertical centerlines further marked in 0.2 division increments. GH (P31) Phosphor is standard; BE (P11) optional. 21 kV accelerating potential.

**Photographic Writing Speed** — At least 1 div/ns with standard GH (P31) Phosphor and at least 2 div/ns with optional BE (P11) Phosphor using the Tektronix C-31B Camera and 3000 speed Type 107 film.

**Auto Focus** — Automatically maintains beam focus for all intensity settings.

**Graticule** — Internal, nonparallax; variable edge lighting; markings for measurement of risetime.

**Beam Finder** — Compresses trace to within graticule area for ease in determining the location of an off-screen signal.

**Z-Axis Input** — Risetime ≈15 ns. Input R ≈500 Ω. +0.2 V (dc to 20 MHz) decreases intensity. +2 V (dc to 2 MHz) blanks maximum intensity trace.

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Operating: −15°C to +55°C. Nonoperating: −35°C to +75°C. Filtered forced air ventilation is provided.

**Altitude** — Operating: To 4600 m (15,000 ft); maximum allowable ambient temperature decreased by 1°C/1000 ft from 5000 ft to 15,000 ft. Nonoperating: To 15 000 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the 3 axes. 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles.

**Humidity** — Operating and Nonoperating: 5 cycles (120 hrs) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, Class 4).

**Shock** — Operating and Nonoperating: 30 g's, ½ sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

### OTHER CHARACTERISTICS

**Two-Frequency, Fast-Rise Calibrator** — Output resistance is 450 Ω with a risetime (positive slope) into 50 Ω of 1 ns or less. 1 kHz, duty cycle 49.8% to 50.2%, Amplitude is 5 V ±0.5% into 1 MΩ and 0.5 V ±1% into 50 Ω (±0.5%). Optional BNC accessory current loop provides 50 mA ±1%. Selectable repetition rates are 1 kHz and 1 MHz ±0.25%. Specifications apply over +15°C to +35°C range.

**A Sweep Output** — Open Circuit: ≈10 V positive-going sawtooth; into 50 Ω, ≈0.5 V.

**A and B Gate Outputs** — Open Circuit: ≈4 V positive-going rectangular pulse; into 50 Ω ≈0.5 V.

**Power Requirements** — Recessed slide switch selects nominal operating line range. Line Voltage Range: 90 V to 136 V and 180 V to 272 V. 60 W maximum power consumption at 115 V. Line Frequency: 48 Hz to 440 Hz.

### PHYSICAL CHARACTERISTICS

| | Cabinet | | Rackmount | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 305 | 12.0 | 483 | 19.0 |
| Height | 168 | 6.6 | 177 | 7.0 |
| Depth | | | 457 | 18.0 |
| (handle extended) | 523 | 20.6 | | |
| (handle not extended | 470 | 18.5 | | |
| **Weights ≈** | **kg** | **lb** | **kg** | **lb** |
| Net (with accessories) | 10.9 | 24.0 | | |
| Net (without accessories) | 9.5 | 21.0 | 11.9 | 26.2 |
| Shipping | 15.0 | 33.0 | 24.5 | 54.0 |

### INCLUDED ACCESSORIES

18 inch 50 Ω BNC cable (012-0076-00); two BNC jack posts (012-0092-00); two 50 Ω terminators (011-0049-01); clear filter (386-0118-00); four 3 amp fuses (159-0015-00); accessory pouch (016-0535-00) or (016-0537-00);. Rack models also include mounting hardware and slide out assemblies. Service manual, operators manual.

Order optional probes from chart.

## ORDERING INFORMATION

**485** Oscilloscope ..... **$8,675**

**R485** Rackmount Oscilloscope ..... **$8,980**

**Option 04** — EMC Modification for 485/R485 ..... **+$200**

**Option 78** — BE (P11) Phosphor ..... **+$150**

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

### OPTIONAL ACCESSORIES

**Passive Probes**

| | Scope Input | Attenuation | Loading | Bandwidth*[1] with 485 |
|---|---|---|---|---|
| P6056 6 ft | 50 Ω | 10X | 500 Ω 1 pF | 350 MHz |
| P6057 6 ft | 50 Ω | 100X | 5000 Ω 1 pF | 350 MHz |
| P6106 2 m | 1 MΩ | 10X | 10 MΩ 13 pF | 250 MHz |
| P6130 1.5 m | 1 MΩ | 10X | 10 MΩ 12.7 pF | 250 MHz |
| P6063B 6 ft | 1 MΩ | Switchable 1X | 1 MΩ 12 pF | 6 MHz |
| | | 10X | 10 MΩ 14 pF | 200 MHz |

**Active Probes**

| | | | | |
|---|---|---|---|---|
| P6230 1.5 m | 50 Ω/1 MΩ | 10X | 450 Ω 1.3 pF | 350 MHz |
| P6201 2 m | 50 Ω/1MΩ | 1X | 100 kΩ 3 pF | |
| | | 10X Head | 1 MΩ 1.5 pF | 330 MHz |
| | | 100X Head | 1 MΩ 1.5 pF | |
| P6202A 2 m | 50 Ω/1 MΩ | 10X | 10 MΩ 2 pF | 285 MHz |
| | | 100X Head | 10 MΩ 2 pF | |

**Current Probes**

| | | | | |
|---|---|---|---|---|
| P6022 5 ft | 1 MΩ | Switchable*[2] 10 mA/div 100 mA/div | 0.03 Ω @ 1 MHz, 0.2 Ω @ 120 MHz | 935 Hz to 120 MHz |
| A6302/ AM 503 2 m | 50 Ω/1 MΩ | Selectable*[2] 1 mA/div to 5 A/div | 0.1 Ω @ 5 MHz, 0.5 Ω @ 50 MHz | Dc to 50 MHz |
| A6303/ AM 503 2 m | 50 Ω/1 MΩ | Selectable*[2] 10 mA/div to 5 A/div | 0.02 Ω @ 1 MHz, 0.15 Ω @ 15 MHz | Dc to 15 MHz |

*[*1] Bandwidths measured at upper −3 dB for given cable lengths.*

*[*2] Scope sensitivity set at 10 mV/div.*

**Carrying Strap** — Order 346-0199-00 ..... **$15**

**Current Loop Adaptor** — The adaptor provides an accurate 50 mA squarewave calibrator when connected to the 485 voltage calibrator. The risetime is ≈25 ns. Order 012-0341-00 ..... **$55**

**50 Ω 5X Pad** — Provides reverse termination for the calibrator. Order 011-0060-02 ..... **$35**

**Folding Viewing Hoods** — Folds to 1.2 x 11.5 x 19.1 cm ($^7/_{16}$ x 7 ½ x 7 ½ in). Order 016-0274-00 ..... **$15**

Folds to 1.4 x 17.2 x 34.9 cm ($^9/_{16}$ x 6 $^3/_4$ x 13 $^3/_4$ in). Order 016-0082-00 ..... **$15**

**K212 Portable Instrument Cart** — For on-site portability. ..... **$330**

**K117 Instrument Shuttle** — For site-to-site portability . **$265**

**See page 429 for complete description on carts.**

**A6902A Isolator** — For floating measurements see page 434 for complete description. Order A6902A ..... **$1,985**

**Battery Power Supply** — Order 1105 Battery Power Supply ..... **$1,550**

**Rack Adaptor** — Order 016-0558-00 ..... **$395**

### RECOMMENDED CAMERAS

**C-30BP General Purpose Camera** — Includes 016-0306-01 mounting adaptor. Order C-30BP ..... **$1,445**

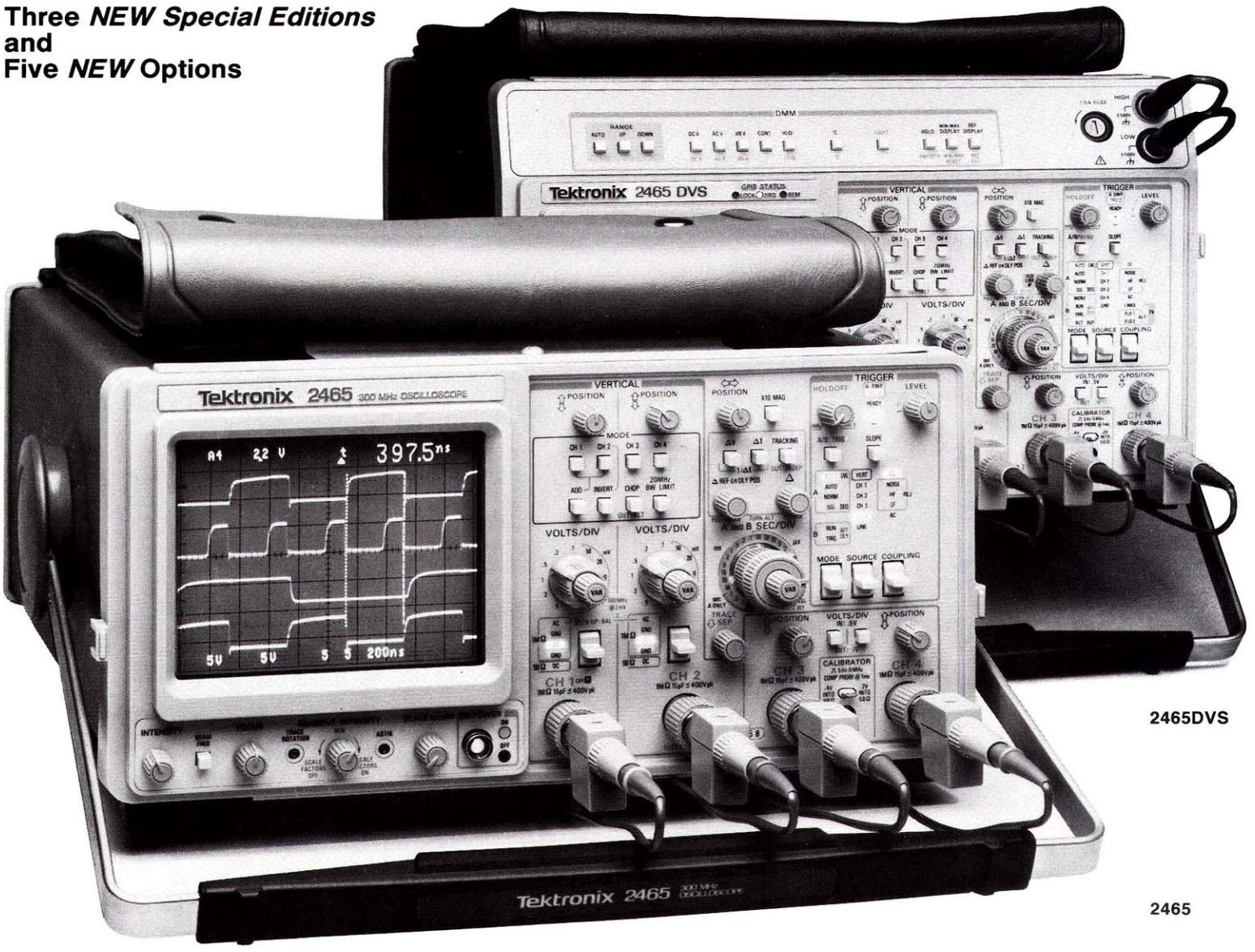
**C-31BP High Speed Camera** — Includes 016-0306-01 mounting adaptor. Order C-31BP ..... **$1,670**

**For further information see camera section.**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

NEW

## Three *NEW Special Editions* and Five *NEW* Options




2465DVS

2465

## 2465/2445

- 300 MHz Bandwidth at Probe Tip (2465)
- 150 MHz Bandwidth at Probe Tip (2445)
- 500 ps/Div Sweep Rate (2465)
- 1 ns/Div Sweep Rate (2445)
- 2 mV/Div Vertical Sensitivity
- 500 MHz (2465) and 250 MHz (2445) Minimum Triggering Bandwidth
- Four Independent Channels
- Waveform Cursors
- Three-Year Warranty—Five Years Optional

The 300-MHz 2465 and 150-MHz 2445 represent the leading edge of technology, establishing higher standards in both value and performance for today's portable oscilloscopes. They enable faster and more precise measurements than ever before possible in a portable oscilloscope. For even more value, Tektronix is offering three *specially priced* products, the 2465DVS, 2465DMS, and 2465CTS. Each is configured with new options to greatly simplify complex measurements and substantially increase user productivity.

GPIB IEEE-488 The 2465/2445 Option 10, 2465DVS, 2465DMS and 2465CTS comply with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats*.

## 2465CTS Special Edition

**2465 Performance PLUS:**

- 10 ps Time Interval Resolution
- Crystal Controlled Time Base
- 0.001% Accuracy
- 150 MHz Counter/Timer
- Delay-By-Events Triggering
- Boolean Logic Triggering
- 17-Bit Word Recognizer Probe
- Fully Programmable

## 2465DMS Special Edition

**2465CTS Performance PLUS:**

- 4 1/2 Digit Autoranging Digital Multimeter
- True RMS Ac Volts and Current
- Continuity Beeper
- DMM Calibration via Front Panel and GPIB
- 10 μV Resolution on Dc Volts
- Fully Programmable

## 2465DVS Special Edition

**2465DMS Performance PLUS:**

- TV Waveform Measurement System
- This System Includes all the 2465 Measurement Options for the Upmost in Versatility and Performance

PORTABLE OSCILLOSCOPES

**2465CTS**

## New Options

Five new options can be ordered with the 2465 or 2445. Their descriptions follow the 2400 Series characteristics.

*GPIB IEEE Standard 488 Programmable for Semiautomatic Measurement Systems (Option 10)*

*150 MHz Counter/Timer/Trigger (CTT) with 17-Bit Word Recognizer (Option 09)*

*150 MHz Counter/Timer/Trigger (CTT) (Option 06)*

*TV Waveform Measurement System (Option 05)*

*4 1/2 Digit Autoranging DMM (Option 01)*

## Multiple Option Allowance

When more than one option is ordered, a Multiple Option Allowance is applied to the purchase.

## Special Edition 2465DVS, 2465DMS, and 2465CTS

For maximum versatility and high-resolution video applications, choose the ***2465DVS***. This is a *specially priced* and configured 2465 with five options: (1) a 4 1/2 digit autoranging digital multimeter (Option 01); (2) a crystal-controlled timebase, 150-MHz counter/timer/trigger and 17-bit word recognizer (Option 09); (3) an IEEE Standard 488 Interface Bus (Option 10) which provides complete talker/listener control, making the 2465DVS programmable; (4) the TV waveform measurement system (Option 05) and (5) two additional P6131 probes (Option 22).

For automatic test and measurement applications, the ***2465DMS***, is a *specially priced* and configured 2465 with Options 01, 09, 10, 22.

The ***2465CTS*** is a *specially priced* and configured 2465 with Options 09, 10, and 22. It is ideal for automatically measuring frequency, period pulse width, and time between events. For moderate speed signals risetimes and falltimes can be automatically measured.

For more information about these instruments, refer to the characteristics and ordering information for the 2465 and the individual options.

## Precision Measurements

*Crystal Controlled Time Base (Option 09/06)*

*ΔVolts and ΔTime Cursors*

*Adjustable Channel 1—Channel 2 Delay Matching*

*Time-Interval Resolution to 20 ps (10 ps Option 09/06)*

*Calibrated Horizontal Variable*

The 2465/2445 Family oscilloscopes set new norms in measurement precision. With 1% horizontal system accuracy and 2% vertical deflection accuracy, they give you greater measurement confidence than ever before. On-screen vertical and horizontal cursors deliver immediate and accurate results of voltage, time, frequency, ratio, and phase measurements.

Cursors increase accuracy and operator productivity. With them, measurements can be made quickly, with almost no chance of interpretation errors and no CRT linearity error. The front-panel-controlled Channel 1—Channel 2 delay-matching adjustment compensates probe and vertical-channel delay differences.

## CRT Readouts

*Vertical and Horizontal Scale Factors*

*Trigger Level*

*Voltage, Time, Frequency, Phase, and Ratio Measurement Values*

*50 Ω Overload Condition*

*Mode Indicators*

Readouts permit easy setup and interpretation of waveform displays. The horizontal time base always remains calibrated with three significant digits and a decimal point, even if variable settings are used.

## Versatile Triggering

*Hands-Off Auto Level Triggering*

*Predictable Triggering on Logic Thresholds and Intermittent Signals*

*Delay-By-Events and Boolean Triggering (Option 09/06)*

These oscilloscopes can trigger on any one of the four channels. New auto-level circuitry gives you convenient hands-off triggering, even with changing trigger-signal amplitudes. With the position-independent triggering, trigger level remains constant whenever you reposition the display. And the trigger-level readout enables you to preset the amplitude for predictable triggering on both logic thresholds and transient events.

Single-sequence triggering can capture a single event or multiple events by displaying a single sweep of each trace on the CRT. At the end of the sequence, scale factors and other readout data are briefly displayed and graticule illumination flashes on momentarily, allowing waveform photography.

## Measurement Convenience

*Four Independent Channels*

*B Sweep Displays A-Sweep Trigger Event*

*Selectable 50 Ω and 1 MΩ Input Impedances with 50 Ω Overload Protection*

Four channels produce clear and complete views to simplify complex measurements. With the B sweep you can display any portion of the A sweep, including the A-sweep trigger event. Sweep-delay range is adjustable down to zero delay. This combination allows easy timing measurements to be made on highly asymmetric or jittering waveforms. It provides accurate delayed- and Δ-time measurements—from the first pulse on the trace—and allows the operator to examine the A-trigger event in detail.

Input impedance is selectable between 1 MΩ and 50 Ω on Channels 1 and 2, eliminating the need for external 50-Ω terminators. Overload protection is also ensured. If excessive signal is applied while 50-Ω coupling is selected, coupling automatically switches to 1-MΩ coupling to prevent possible damage.

## Environmental

Exceptional electromagnetic compatibility qualities make the 2465/2445 Family oscilloscopes attractive for use in high-RF situations such as computer manufacturing, testing, and servicing. These instruments are also UL listed and CSA certified for safety. Their rugged design meets MIL-T-28800C environmental requirements for Type III, Class 3, Style C equipment.

## Reliability

Because of our confidence in their trouble-free performance, Tektronix offers a three-year warranty. It covers all labor and parts, including CRT and excluding probes. You can also economically extend the warranty coverage up to five years by choosing from five practical service plans. These optional plans are designed to meet specific maintenance needs and are available in most countries.

NEW

## CHARACTERISTICS

Characteristics are common to the 2465/2445 Family except where indicated.

### VERTICAL DEFLECTION SYSTEM

**Vertical Display Modes** — CH 1, CH 2, CH 3, CH 4, Add (CH 1 + CH 2); Invert (CH 2 only); Alternate and Chopped. Bandwidth Limit (20 MHz). If Var V/Div knob is rotated out of detent, efficient RATIO measurements can be performed with ΔV cursors.

### CHANNEL 1 AND CHANNEL 2

**Deflection Factor Range** — 2 mV/div to 5 V/div in a 1-2-5 sequence.

**Accuracy** — ±2% for ≤5 div signals centered vertically for temperatures from +15°C to +35°C. Add ±1% of reading for temperatures from −15°C to +15°C and +35°C to +55°C. For 50 Ω Coupling, add ±1%. For CH2 Invert, add ±1%.

**ΔV Accuracy** — ±(1.25% of reading + 0.03 div + signal aberrations) for temperatures from +15°C to +35°C. Add 1% of reading for temperatures from −15°C to +15°C and +35°C to +55°C. For 50 Ω Coupling, add ±1%. For CH2 Invert, add ±1%. Measured with cursors, over the entire graticule area.

**ΔV Range** — ±8 times the Volts/Div switch setting.

**Variable Range** — Continuously variable between Volts/Div switch settings. Extends maximum deflection factor to at least 12.5 V/div.

**Frequency Response (3 dB Bandwidth and Risetime*[1])** — With a 6 div signal, terminated in 50 Ω, with Var Volts/Div in calibrated detent.

| 2465 | Volts/Div Setting | With Standard Accessory Probe or Internal 50 Ω Termination |
|---|---|---|
| −15°C to +35°C | ≥5 mV | Dc to 300 MHz, 1.17 ns |
| +35°C to +55°C | ≥5 mV | Dc to 250 MHz, 1.4 ns |
| −15°C to +55°C | 2 mV | Dc to 100 MHz, 3.5 ns |
| **2445** | | |
| −15°C to +35°C | ≥5 mV | Dc to 150 MHz, 2.33 ns |
| +35°C to +55°C | ≥5 mV | Dc to 100 MHz, 3.5 ns |
| −15°C to +55°C | 2 mV | Dc to 80 MHz, 4.38 ns |

*[1] Risetime calculated from: Bandwidth x Risetime = 0.35*

**Ac Coupled Lower −3 dB Point** — With 1X Probe: 10 Hz or less. With 10X Probe: 1 Hz or less.

**Common-Mode Rejection Ratio** — At least 20:1 at 50 MHz for common-mode signals of 8 div or less, with Var Volts/Div control adjusted for best CMRR at 50 kHz at any Volts/Div setting ≥5 mV. At least 20:1 at 20 MHz at 2 mV/div.

**Channel Isolation** — 100:1 or greater attenuation of the deselected channel at 100 MHz; 50:1 or greater attenuation at 300 MHz (for 2465); 50:1 or greater attenuation at 150 MHz (for 2445). Measured with an eight-division input signal, deflection factors from 2 mV/div to 500 mV/div, and with equal Volts/Div switch settings on both channels.

**Displayed CH 2 Signal Delay with Respect to CH 1 Signal** — Adjustable through a range of at least ±500 ps.

**Input Z (1 MΩ)** — 1 MΩ ±0.5% shunted by 15 pF, ±2 pF. The maximum input voltage is 400 V (dc + peak ac); 800 V p-p ac at 10 kHz or less, for ac and dc coupling.

**Input Z (50 Ω)** — 50 Ω ±1%, with vswr of ≤1.3:1 from dc to 300 MHz (for 2465), or from dc to 150 MHz (for 2445). Maximum input voltage is 5 V RMS with 1-s averaging internal, ±50 V peak.

**Cascaded Operation** — CH 2 Signal Out is coupled into CH 1 input. Bandwidth is dc to 50 MHz or greater and the deflection factor is 400 μV/div ±10%.

### CHANNEL 3 AND CHANNEL 4

**Deflection Factor** — 0.1 V/div and 0.5 V/div ±10%.

**Frequency Response (Bandwidth and Risetime)*[1]**

| 2465 | With Standard Accessory Probe (−3 dB) | With 50 Ω External Termination |
|---|---|---|
| −15°C to +35°C | Dc to 300 MHz 1.17 ns | Dc to 300 MHz, (−4.7 dB) 1.4 ns |
| +35°C to +55°C | Dc to 250 MHz 1.4 ns | Dc to 250 MHz, (−4.7 dB) 1.75 ns |
| **2445** | | |
| −15°C to +55°C | Dc to 150 MHz 2.33 ns | Dc to 150 MHz, (−3 dB) 2.33 ns |

*[1] With a 6 div signal, from a 50 Ω terminated source.*

**Input Z** — 1 MΩ ±1%, shunted by 15 pF ±3 pF.

**Maximum Input Voltage** — ±400 V (dc + peak ac): 800 V p-p ac at 10 kHz or less.

**Channel Isolation** — 50:1 or greater attenuation of the deselected channel at 100 MHz with an 8 div input signal.

### ALL CHANNELS

**Low Frequency Linearity** — 0.1 div or less compression or expansion of a 2 div, center-screen signal when positioned anywhere within the graticule area.

**Bandwidth Limiter** — Reduces upper 3 dB bandpass to a limit of 13 MHz to 24 MHz.

**Vertical Signal Delay** — At least 30 ns of the signal is displayed before the triggering event is displayed on the A sweep for settings ≥10 ns/div. At least 10 ns of delay is displayed at 5 ns/div for the 2465.

**Chopped Mode Switching Rate** — 2.5 MHz ±0.2% from 2 μs/div to 20 μs/div (1.25 MHz dual channel cycle rate). At All Other Sweep Speeds: 1 MHz ±0.2% (500 kHz dual channel cycle rate).

### HORIZONTAL DEFLECTION SYSTEM

**Horizontal Display Modes** — A, A Intensified, B Delayed, Alternate (A Intensified and B Delayed), B ends A for increased intensity in the delayed mode. For X-Y operation Channel 1 supplies the x-axis (horizontal) deflection.

**A Sweep Time Base Range**

2465: 0.5 s/div to 5 ns/div in a 1-2-5 sequence of 25 steps. X10 Mag feature extends maximum sweep speed to 500 ps/div.

2445: 1 s/div to 10 ns/div in a 1-2-5 sequence of 25 steps. X10 Mag feature extends maximum sweep speed to 1 ns/div.

**B Sweep Time Base Range**

2465: 50 ms/div to 5 ns/div in a 1-2-5 sequence of 22 steps. X10 Mag feature extends maximum sweep speed to 500 ps/div.

2445: 50 ms/div to 10 ns/div in a 1-2-5 sequence of 21 steps. X10 Mag feature extends maximum sweep speed to 1 ns/div.

**Variable Time Control** — Continuously variable and calibrated between settings of the Sec/Div switch. Extends slowest A sweep speed to 1.5 s/div. Operates in conjunction with the A Sec/Div switch when A and B are locked together; operates in conjunction with the B Sec/Div switch when A and B are not locked together. When Var is out of detent position, the ΔT cursors give RATIO measurements, where five horizontal div are 100%. The variable control causes 1/ΔT cursors to give PHASE measurements where five horizontal div are 360°.

### CALIBRATED SWEEP DELAY

**Timing Accuracy** — Measured with Sec/Div switches set to 0.1 s/div or faster and temperature from +15°C to +35°C. (Refer to note below.)

| Parameter | Unmagnified | Magnified |
|---|---|---|
| A and B Sweep*[1] | ±(0.7% of time interval +0.6% of full scale) | ±(1.2% of time interval +0.6% of full scale) |
| ΔTime (with Cursors)*[2] | ±(0.5% of time +0.3% of full scale) | ±(1% of time inteval +0.3% of full scale) |
| ΔTime (with Delayed B Sweep)*[3] | ±(0.3% of time interval +0.1% of full scale) | |
| Delay Time*[4] | ±(0.3% of delay setting +0.6% of full scale), +0 ns, −25 ns | |

*[1] Time interval is measured on the center horizontal graticule line with Var Sec/Div control in detent (0.6% full scale is 0.06 div).*

*[2] Time interval is measured with cursors, anywhere on the graticule.*

*[3] Time interval is measured with Delayed B Sweep and with both delays set at 1% or more of full scale from minimum delay (no "?" displayed in readout).*

*[4] Delay time is from A Sweep trigger point to start of B Sweep.*

**NOTE:** With the A Sec/Div switch set to either 0.5 s or 0.2 s, add 0.5% of time interval to all accuracy specifications.

With the A Sec/Div switch set to 1 s (2445 only), add 2% of time interval to all accuracy specifications.

With the Var Sec/Div control out of detent, add 2% to both the A Sweep and the B Sweep accuracy specifications (except 1 s/div setting for 2445).

For temperature from −15°C to +15°C and from +35°C to +55°C, add 0.2% of time interval to all ΔTime and Delay Time specifications; add 0.5% of time interval to the A Sweep and the B Sweep accuracy specifications.

**ΔTime Readout Resolution**

2465: Greater of either 10 ps or 0.025% full scale.

2445: Greater of either 20 ps or 0.025% full scale.

**ΔTime Range** — ±10 times the A Sec/Div switch setting.

**Delay Pickoff Jitter** — Within 0.004% (one part or less in 25,000) of the maximum available delay, plus 100 ps.

**Delay Time Position Range** — 0 to 9.95 times the A Sec/Div switch setting. Main sweep triggering event is observable on delayed sweep with minimum delay setting.

### TRIGGERING

The minimum p-p signal amplitude for stable triggering is stated for CH 1 or CH 2 source. The signal amplitude for CH 3 or CH 4 source is one-half of CH 1 or CH 2 source specification. For multiple channel source (Alternate Vertical Mode) add 1 div to the single channel source specification.

**Dc Coupled** — 0.35 div from dc to 50 MHz, increasing to 1.5 div at 500 MHz (250 MHz for 2445).

**Noise Reject Coupled** — 1.2 div from dc to 50 MHz, increasing to 4.5 div at 500 MHz (250 MHz for 2445). An amplitude sensing mode, defined by increased trigger hysteresis. For signals within the vertical bandwidth, triggering *will not* occur (signal reject) with 0.4 div or less.

**Ac Coupled** — 0.35 div from 60 Hz to 50 MHz, increasing to 1.5 div at 500 MHz (250 MHz for 2445). Attenuates signals below 60 Hz.

**HF Reject Coupled** — 0.5 div from dc to 30 kHz.

**LF Reject Coupled** — 0.5 div from 80 kHz to 50 MHz, increasing to 1.5 div at 500 MHz (250 MHz for 2445).

**Jitter** — Less than 50 ps at 300 MHz with A and B Sec/Div set for 5 ns/div sweep and 10X Mag on (100 ps at 150 MHz and 10 ns/div for 2445).

**Trigger Level Control Range** — CH 1 or CH 2: ±18 times the Volt/Div setting. CH 3 or CH 4: ±9 times the Volts/Div setting.

**Trigger Level Control Readout Accuracy** — For triggering signals with transition times >20 ns.

**Channel 1 or Channel 2 Source (Dc Coupled):** ±[3% of Level setting +3% of p-p signal +0.2 div + 0.5 mV + (0.5 mV x probe attenuation factor)] for temperatures from +15°C to +35°C. Add 1.5 mV x probe attenuation factor for temperatures from −15°C to +15°C and +35°C to +55°C.

**Channel 1 and Channel 2 (50 Ω Coupled, Channel 2 Invert):** Add ±1% of setting to dc coupled specification at +15°C to +35°C.

**Channel 1 or Channel 2 Source (Noise Reject Coupled):** Add ±0.6 div to the dc coupled specification.

**Channel 3 or Channel 4 Source (Dc Coupled):** ±[3% of Level control setting +4% of p-p signal +0.1 div +(0.5 mV x probe attenuation factor)].

**Channel 3 or Channel 4 Source (Noise Reject Coupled):** Add ±0.3 div to the Dc Coupled specification.

**Auto Level Mode Maximum Triggering-Signal Period** — At least 20 ms with A Sec/Div settings <10 ms/div. At least four times the A Sec/Div setting with settings from 10 ms/div to 50 ms/div. At least 200 ms with A Sec/Div switch settings >50 ms/div.

**Auto Mode Maximum Triggering-Signal Period** — At least 80 ms with A Sec/Div settings <10 ms/div. At least 16 times the A Sec/Div settings from 10 ms/div to 50 ms/div. At least 800 ms with A Sec/Div setting >50 ms/div.

**Auto Level Mode Trigger-Acquisition Time** — From 8 to 100 times the specification for Auto Level Mode Maximum Triggering-Signal Period, depending on the triggering-signal period and waveform.

**Slope Selection** — Conforms to trigger-source waveform or ac power-source waveform.

**A Trigger Holdoff** — An adjustable control permits a stable presentation of repetitive complex waveforms. Extends A sweep holdoff to at least 10 times Sec/Div setting. At the fully clockwise setting, B sweep ends A sweep.

### X-Y OPERATION

**Three-Channel X-Y Display** — Channel 1 supplies the X-axis (horizontal) deflection signal. Any or all of the vertical channels (including Channel 1) can supply the Y-axis (vertical) deflection signal(s).

**X-Axis Deflection Factor Range, Variable Range, and Accuracy** — Same as Channel 1.

**X-Axis Bandwidth** — Dc to 3 MHz.

**Input Z** — Same as Channel 1.

**Phase Difference Between X and Y (Without Bandwidth Limit)** — ≤1° from dc to 1 MHz. ≤3° from 1 MHz to 2 MHz.

**X-Axis Low-Frequency Linearity** — 0.2 div or less compression or expansion of a two-div, center-screen signal when positioned within the graticule area.

PORTABLE OSCILLOSCOPES

### CURSOR AND FRONT PANEL DISPLAY

**ΔVolts Cursor Position Range** — At least the center 7.6 vertical divisions.

**ΔTime Cursor Position Range** — At least the center 9.6 horizontal divisions.

**Power Down Memory** — Front panel settings will be stored in nonvolatile memory provided no controls are moved for at least 10 s before power down.

### Z-AXIS INPUT

**Sensitivity** — Positive voltage decreases intensity. From dc to 2 MHz, +2 V blanks a maximum-intensity trace. From 2 MHz to 20 MHz, +2 V p-p modulates a normal-intensity trace.

**Input Resistance** — 9 kΩ ±10%.

**Maximum Input Voltage** — ±25 V peak; 25 V p-p ac at 10 kHz or less.

### SIGNAL OUTPUTS

**Calibrator** — Measured with the Sec/Div setting at 1 ms/div.

**Output Voltage and Current:** 0.4 V ±1% into a 1 MΩ load, 0.2 V ±1.5% into a 50 Ω load, or 8 mA ±1.5% into a short circuit.

**Repetition Period and Accuracy:** Two times the A Sec/Div setting for settings from 100 ns/div to 100 ms/div. Accuracy is ±0.1%, measured during sweep time or with Single Sequence A Trigger Mode selected.

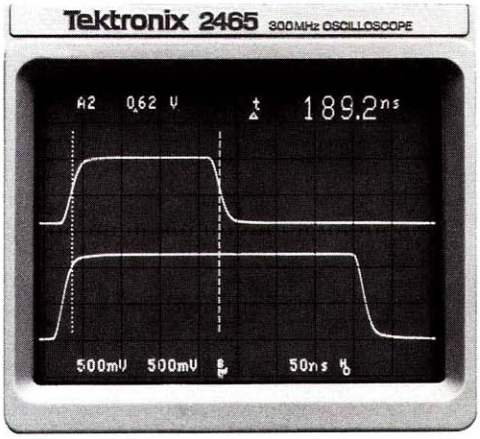
**Symmetry:** Duration of high-portion output cycle is 50% of the output period ±(the lesser of 500 ns or 25% of period).

**Pulse-Period or Pulse-Width Jitter:** 10 ns or less.

**CH 2 Signal Out:** Output Voltage: 20 mV/div ±10% into 1 MΩ, 10 mV/div ±10% into 50 Ω. Offset: ±10 mV into 50 Ω when dc balance has been performed within ±5°C of the operating temperature.

**A Gate Out and B Gate Out:** Output Voltage: 2.4 V to 5 V positive going pulse, starting at 0 V to 0.4 V. Output Drive: Will supply 400 μA during HI state; will sink 2 mA during LO state.

### CRT READOUT AND WAVEFORM INFORMATION




*Your eyes never have to leave the screen to obtain front panel settings and measurement results.*
*In the CRT example above, the top area of the display provides trigger source, trigger voltage level, and Δtime results. The lower area displays the selected volts/div and seconds/div scale factors and that bandwidth limit and holdoff are activated.*

### DISPLAY

**CRT** — 80 mm x 100 mm (8 cm x 10 cm).

**Standard Phosphor** — GH (P31) is standard.

**Nominal Accelerating Potential** — 16 kV.

### AC POWER SOURCE

**Voltage Ranges** — 115 V: 90 V to 132 V. 230 V: 180 V to 250 V.

**Source Frequency** — 48 Hz to 440 Hz.

**Power Consumption** — Typical: 70 W (140 VA). Maximum: 120 W (180 VA).

### ENVIRONMENTAL AND SAFETY CHARACTERISTICS

The 2465/2445 Family oscilloscopes meet or exceed the environmental requirements of MIL-T-28800C for Type III, Class 3, Style C equipment, tested for humidity 4.5.5.1.2.2, low temperature 4.5.5.1.3 and high temperature 4.5.5.1.4.

**Temperature** — Operating: −15°C to +55°C. Nonoperating: −62°C to +85°C.

**Humidity** — Operating and Nonoperating: Stored at 95% relative humidity for 5 cycles (120 hours) from +30°C to +60°C, with operational performance checks at +30°C and +55°C.

**Drip Proof** — With Cover On: Meets MIL-T-28800C Para. 4.5.5.5.3.

**Altitude** — Operating: To 4600 m (15,000 ft). Maximum operating temperature decreases 1°C for each 1,000 ft above 5,000 ft. Nonoperating: To 15 000 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of three axes at a total displacement of 0.025 inch p-p (4 g at 55 Hz), with frequency varied from 10 Hz to 55 Hz in one-minute sweeps. Held 10 minutes at each major resonance, or if none existed, held 10 minutes at 55 Hz (75 minutes total test time).

**Shock** — Operating and Nonoperating: 50 g, half-sine, 11 ms duration, three shocks on each face, for a total of 18 shocks.

**Transit Drop** — Not in Shipping Package: 12 inch drop on each corner and each face (MIL-T-28800C, para 4.5.5.4.2).

**Bench Handling** — With and Without Cabinet Installed: MIL-STD-810C, Method 516, Procedure V (MIL-T-28800C, para 4.5.5.4.3).

**Topple** — Operating and Cabinet Installed: Set on rear feet and allowed to topple over onto each of four adjacent faces.

**Packaged Transportation Drop** — Meets the limits of the National Safe Transit Association Test Procedure 1A-B-2; 10 drops of 36 inches.

**Packaged Transportation Vibration** — Meets the limits of the National Safe Transit Association Test Procedure 1A-B-1; excursion of 1 inch p-p at 4.63 Hz (1.1 g) for 30 minutes.

**Safety** — UL listed (UL 1244) and CSA certified (CSA 556B).

**Electromagnetic Compatibility** — Meets MIL-STD-461B for the following tests: RE02 Part 4 and 7; CE01 Part 2; CE03 Part 2; CS01 Part 2; CS02 Part 2; CS06 Part 2; RS01 Part 2; RS03 1 V/meter up to 1 GHz.
Meets FCC Rules and Regulations, Part 15, Subpart J, Class A. Meets VDE 0871, Category B.

### PHYSICAL CHARACTERISTICS

| For Standard Scope & Options | Cabinet | | Option 1R Rackmount | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | | | 483 | 19.0 |
| (with handle) | 330 | 13.0 | | |
| Height | | | 178 | 7.0 |
| (with feet/pouch) | 190 | 7.5 | | |
| (without pouch) | 160 | 6.3 | | |
| (with Opt 01, with feet/pouch) | 230 | 9.0 | | |
| (with Opt 01,w/o pouch) | 199 | 7.8 | | |
| Depth | | | 419 | 16.5 |
| (with front panel cover) | 434 | 17.1 | | |
| (with handle extended) | 505 | 19.9 | | |
| **Weights** | **kg** | **lb** | **kg** | **lb** |
| Net (w/o accessories & pouch) | 9.3 | 20.5 | 13.3 | 29.3 |
| (with Opt 01 w/o accessories and pouch) | 9.9 | 22.0 | | |
| (with accessories & pouch) | 10.2 | 22.4 | 14.2 | 31.2 |
| (with Opt 01 with accessories and pouch) | 13.0 | 28.8 | | |
| Shipping | 12.8 | 28.2 | 19.1 | 42.0 |
| (with Opt 01) | 14.9 | 33.0 | | |

### INCLUDED ACCESSORIES

Two P6131 10X 1.3 m probes with accessories (010-6131-01); ziploc accessory pouch (016-0537-00); blue plastic CRT filter (378-0199-00); clear plastic CRT filter (378-0208-00); 2 A, 250 V fuse (159-0021-00); snap accessory pouch (016-0692-00); front cover (200-2742-00); power cord (161-0104-00). 2445 operator manual; and reference guide. 2465 operator manual; and reference guide.

**Option 1R** — Rackmount hardware and slide out assemblies, does not include pouch.

## GPIB IEEE-488 OPTION 10 GPIB Interface

**All of the High Performance Characteristics of Standard 2465/2445 Oscilloscopes Plus Programmability**

**Remote Control of Front Panel Functions**

**Selectable at Front Panel:**
- **Device Address**
- **Talk/Listen Mode**
- **Message Terminator**

**Front Panel Status Indicators:**
- **REM (Remote)**
- **SRQ (Service Request)**
- **LOCK (Local Lockout)**

**Compatible with All Other 2465/2445 Options**

**Bus Interface Complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats***

Option 10, which adds the ability to communicate over the General Purpose Interface Bus, transforms the 2465/2445 Family oscilloscopes into ideally suited components for use in a variety of semiautomatic test or measurement systems.

A host controller, such as the Tektronix 4041 can be easily programmed to assist the oscilloscope operator in performing a complete sequence of tests and measurements. Front panel settings can be remotely set or changed. It is possible not only to display scope parameters and settings on the CRT, but also to read them back over the GPIB to the controller. Similarly, the results of voltage, time, frequency, phase, and ratio measurements can be both displayed on the CRT and communicated back over the bus.

The ability to display prompting messages (by embedding them in control programs) reduces the chance of operator error at critical points in a test procedure.

Message structure for the 2465/2445 Family, like that for other Tektronix GPIB-controllable instruments, conforms with Tektronix *Standard Codes and Formats*. The abilty to select message termination characters facilitates use with most types of controllers.

### CHARACTERISTICS

The set of characteristics is the same as specified for standard 2465/2445 oscilloscopes and includes the following additions:

**Standard Interface Functions Implemented** — SH1, AH1, T6, L3, SR1, RL1, DC1, E1 DT0 C0, PP0.

**Vertical Position Accuracy** —

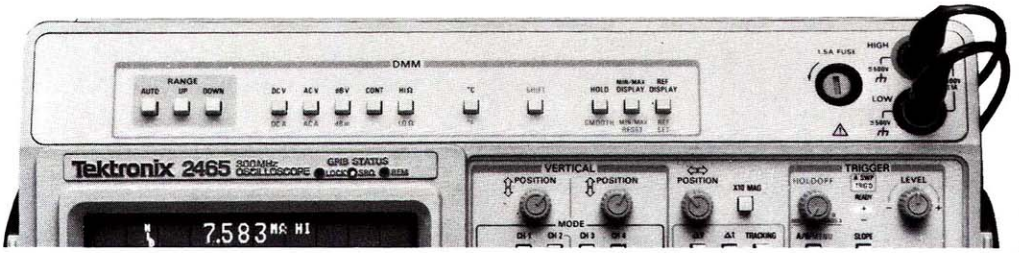
**Channel 1 and Channel 2 (Noninverted):** ±[0.3 div +3% of distance (in divisions) from center screen +0.5 mV divided by the V/div setting]. Channel 2 Inverted: Add 0.2 div for −15°C to +55°C (excluding +15°C to +35°C) add 1.5 mV divided by the V/div setting.

**Channel 3 and Channel 4:** ±[0.7 div +3% of distance (in div) from center screen].

### INCLUDED ACCESSORIES (Option 10)

In addition to the accessories listed for 2465 and 2445 instruments, an operator's manual and reference guide are provided.

NEW




## OPTION 01 Digital Multimeter

**All of the High Performance Characteristics of Standard 2465/2445 Oscilloscopes Plus a 4 1/2 Digit Autoranging Digital Multimeter**

**True RMS Ac Volts from 20 Hz to 100 kHz**

**True RMS Ac Current from 20 Hz to 10 kHz**

**10 μV Resolution on Dc Volts**

**Continuity Beeper**

**UL Listed, CSA Certified**

**Temperature Probe −62°C to +230°C**

**Calibration via Front Panel without Removing Instrument Covers**

**Convenience Features Include: Set Reference, Hold, Smooth, Minimum/Maximum, dBV, and dBm**

Option 01 (DMM) complements the measurement demands placed on the 2400 Series oscilloscopes. This 4 1/2 digit DMM offers features not normally found on other DMMs in its class, such as: (1) Direct readout of dBV and dBm; (2) Continuity with audible tone; (3) Display of minimum or maximum values of readings that occurred since the last reset or function change; (4) Averaging blocks of accumulated measurement values to create a smoothing or filtering effect when desired; (5) Rugged, designed to meet or exceed the requirements of MIL-T-28800C, Class 3 environment, thus ensuring reliable operation under the same temperature and humidity extremes as the 2400 Series oscilloscopes; (6) UL listed and CSA certified.

### CHARACTERISTICS

The set of characteristics is the same as specified for standard 2465/2445 oscilloscopes and includes the following additions:

All accuracy specifications are stated with an operating temperature range of +18°C to +28°C and a relative humidity of 95% or less.

#### DC VOLTAGE

**Ranges** — 200 mV, 2 V, 20 V, 200 V, 500 V.

**Resolution** — 10 μV (4 1/2 digits).

**Accuracy** — ±(0.03% of reading +0.01% of full scale). For 500 V range ±(0.03% of reading + 0.04% of full scale).

**Input Resistance** — >100 GΩ on the 0.2 V and 2 V ranges, 10 MΩ on the higher ranges. Resistance can be changed to 10 MΩ on all ranges.

**Normal-Mode Rejection Ratio** — ≥60 dB at 50 Hz and 60 Hz.

**Common-Mode Rejection Ratio** — 100 dB at dc, >80 dB at 50 Hz and 60 Hz with 1 kΩ imbalance.

**Maximum Input Voltage** — 500 V RMS, 700 V peak between inputs and ground.

**Response Time** — <2 s in Auto, <1 s in Manual range.

#### AC RMS VOLTAGE

**Ranges** — 200 mV, 2 V, 20 V, 200 V, 500 V.

**Resolution** — 10 μV (4 1/2 digits).

**Accuracy** — ±(% of reading +% of full scale).

| Ranges | 200 mV to 200 V | 500 V |
|---|---|---|
| 20 Hz to 40 Hz | ±(0.7% +0.1%) | ±(0.7% +0.2%) |
| 40 Hz to 10 kHz | ±(0.3% +0.1%) | ±(0.3% +0.2%) |
| 10 kHz to 20 kHz | ±(0.7% +0.1%) | ±(0.7% +0.2%) |
| 20 kHz to 100 kHz | ±(5% +0.1%) | ±(5% +0.2%) |

**Crest Factor** — ≤4 at full scale.

**Common-Mode Rejection Ratio** — ≥60 dB at 50 Hz and 60 Hz with 1 kΩ imbalance.

**Response Time** — <3 s in Auto, <2 s in Manual range.

**Input Impedance** — 1 MΩ in parallel with <100 pF.

**Maximum Input Voltage** — 500 V RMS, 700 V peak between inputs and ground, not to exceed $10^7$ V-Hz product.

**dBV, dBm** — Calculated reading of ac voltage measurements. dBV is the display result equal to 20 Log ($V_{UNK}/V_{REF}$) where $V_{REF}$ = 1 V. dBm is referenced 1 mW into 600 Ω

#### HI Ω RESISTANCE

**Ranges** — 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ 20 MΩ.

**Accuracy** — ±(0.1% of reading +0.01% of full scale) for 2 kΩ to 2 MΩ, ±(0.5% of reading +0.01% of full scale) for 20 MΩ. For Relative Humidity (RH) above 70%, add 2% of reading per 10% RH for the two highest resistance ranges.

**Maximum Input Voltage** — 500 V RMS 700 V peak.

**Full Scale Voltage** — 2 V.

**Open Circuit Voltage** — <6 V.

**Resolution** — 0.1 Ω (4 1/2 digits).

**Response Time** — <2 s in Auto, <1 s in Manual range. <5 s in 20 MΩ range.

#### LO Ω RESISTANCE

**Ranges** — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ.

**Accuracy** — ±(0.1% of reading +0.1% of full scale) for 200 Ω, ±(0.1% of reading +0.01% of full scale) for 2 kΩ to 200 kΩ, ±(0.25% of reading +0.01% of full scale) for 2 MΩ. For Relative Humidity (RH) above 70%, add 2% of Reading per 10% RH for the two highest resistance ranges.

**Maximum Input Voltage** — 500 V RMS, 700 V peak.

**Full Scale Voltage** — 0.2 V.

**Open Circuit Voltage** — <6 V.

**Resolution** — 0.01 Ω

**Response Time** — <2 s in Auto, <1 s in Manual range.

**Continuity** — An audible tone indicates <10 Ω. Reponse time is ≈0.1 s.

#### DC AMPS

**Ranges** — 100 μA, 1 mA, 10 mA, 100 mA, 1 A.

**Accuracy** — ±(0.1% of reading +0.02% of full scale).

**Burden Voltage** — <150 mV up to 100 mA increasing to <500 mV at 1 A.

**Resolution** — 10 nA.

**Response Time** — <2 s in Auto, <1 s in Manual range.

#### AC (RMS) AMPS

**Ranges** — 100 μA, 1 mA, 10 mA, 100 mA, 1 A.

**Accuracy** — ±(0.6% of reading +0.1% of full scale) from 20 Hz to 10 kHz.

**Burden Voltage** — <150 mV up to 100 mA increasing to <500 mV at 1 A.

**Resolution** — 10 nA.

**Response Time** — <3 s in Auto, <2 s in Manual range.

#### TEMPERATURE

**Range** — −62°C to +230°C, ±(2% of reading +1.5°C). Readout may be in °C or °F with a resolution of 0.1°.

#### OTHER CHARACTERISTICS

**Reading Rate** — Three readings/s nominal except 1.5 readings/s on 20 MΩ range.

**Temperature Coefficient** — ≤0.1 x the accuracy specification/°C from −15°C to +18°C and from +28°C to +55°C.

**GPIB Compatibility for Semiautomatic Measurement Systems** — When combined with Option 10, the DMM (Option 01)/oscilloscope combination is fully programmable. Complies with Tektronix *Standard Codes and Formats*.

#### INCLUDED ACCESSORIES (Option 01)

In addition to the accessories listed for 2465 and 2445 instruments, a probe set (012-0941-00); probe set accessories (020-0087-00); temperature probe (010-6602-00); and DMM operator's manual and reference guide are provided.

## OPTION 09

### Counter/Timer/Trigger (CTT) With Word Recognizer (WR)

**All of the High Performance Characteristics of Standard 2465/2445 Oscilloscopes Plus Crystal-Controlled Time Base**

**0.001% Accuracy**

**Totalize up to 9,999,999 Events**

**Delay-By-Events Triggering up to a Total of 4,194,303 Events**

**Boolean Logic Triggering on Both Digital and Analog Signals**

**17-Bit Word Recognizer Probe**

Adding Option 09 to the 2400 Series oscilloscopes provides crystal-controlled time base accuracy for several time related measurements. Its use is fully integrated with the operation of the oscilloscope and with user on-screen menus. Four new 2400 Series capabilities are provided by this option: (1) Precision time-interval measuring; (2) Event and frequency counting; (3) Delay-by-events triggering; (4) Boolean logic triggering.

A 17-Bit word recognizer probe is available for a variety of applications, such as triggering on a word occurrence, counting words, or delaying the B sweep by a number of words.

### CHARACTERISTICS

The set of characteristics is the same as specified for standard 2465/2445 oscilloscopes and includes the following additions:

**Sensitivity** — Signal input requirements for Frequency, Period, Totalize, Delay-by-Events and Logic Trigger.

| Input | Displayed Signal | Frequency Range |
|---|---|---|
| CH1, CH2 | 1.5 div | Dc (0.5 Hz for Frequency and Period) to 50 MHz |
| CH3, CH4 | 0.75 div | |
| CH1, CH2 | 4.0 div | 50 MHz to ≥150 MHz |
| CH3, CH4 | 2.0 div | |

**Source** — A trigger or word recognizer for Frequency, Period, and Totalize.

PORTABLE OSCILLOSCOPES

### FREQUENCY

**Range** — Autoranging over input frequency from 0.5 Hz to 150 MHz.

**Resolution** — $\pm\left[\text{LSD} + 1.4 \times \frac{\text{TJE}}{\text{N}} \times (\text{F})^2\right]$

Where: LSD = Least Significant Digit (0.1 ppm of full scale)
TJE = Trigger Jitter Error
N = Number of cycles of measured frequency during measurement interval (0.5 s or 1 period of the input signal, whichever is greater).

**Display** — Seven digits, updates twice per second or every two periods, whichever is slower.

**Accuracy** — Resolution ±0.001% of reading over entire temperature range of −15°C to +55°C.

### PERIOD

**Range** — Autoranging over an input period from 6.666667 ns to 2 s.

**Resolution** — $\pm\left(\text{LSD} + 1.4 \times \frac{\text{TJE}}{\text{N}}\right)$

Where: LSD = Least Significant Digit (0.1 ppm of full scale)
TJE = Trigger Jitter Error
N = Number of cycles of measured frequency during measurement interval (0.5 s or 1 period of the input signal, whichever is greater).

**Display** — Seven digits, updates twice per second or every two periods, whichever is slower.

**Accuracy** — Resolution ±0.001% of reading over entire temperature range of −15°C to +55°C.

### ACCURACY AND RESOLUTION DEFINITIONS

**TJE (Trigger Jitter Error)** = $\sqrt{\frac{(\text{en1})^2 + (\text{en2})^2}{\text{Input Slew Rate}}}$

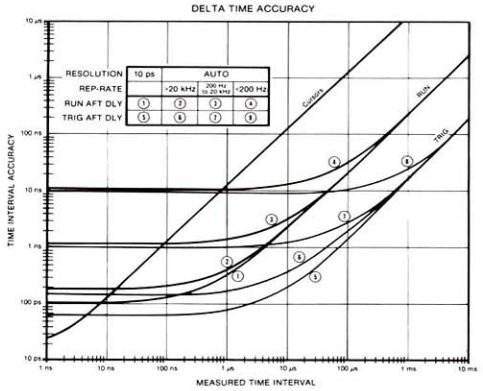
Where: en1 = RMS noise of vertical system in div on screen.
en2 = RMS noise voltage of input signal in divs.

| Volts/Div | Trigger Coupling | |
|---|---|---|
| | en1 Dc and Noise Rej | en2 HF Reject |
| 2 mV | 0.15 div | 0.05 div |
| 5 mV to 5 V | 0.1 div | 0.05 div |

### ΔTIME, 1/ΔTIME

**TRIG AFT DLY Accuracy** — ±(LSD +0.01 x B Time/div + 0.001% x A Sec/div +0.001% of reading +50 ps). Measured with signals (visually superimposed) having minimum Trigger Jitter Error and with channel-to-channel delay mismatch nulled out. (B Time/div includes 10X mag.)

**RUN AFT DLY Accuracy** — ±(LSD +0.0008 x A Sec/Div +0.01 x B Time/Div + 83 ps). (B Time/Div includes 10X mag.)




*Note:*
*Input Signal is five vertical div with a 2 ns risetime.*
*Measured times are four horizontal div.*
*TJE is negligible for Slew Rates >0.1 div/ns.*
*ΔTime-TRIG AFT DLY assumes visual superposition.*

**Display Update Rate** — Auto resolution, twice per second or every four sweeps, whichever is slower. Depends on trigger and sweep rates with selectable resolution.

### PULSE WIDTH (ALT SLOPE)

When selected, displays the time interval defined by opposite slopes of a waveform using triggered delayed sweep.

**Accuracy** — Same as Δtime Triggered Mode.

**Minimum Pulse Width** — ≥1 ns.

**Display Update Rate** — Same as Δtime Mode.

### DELAY TIME

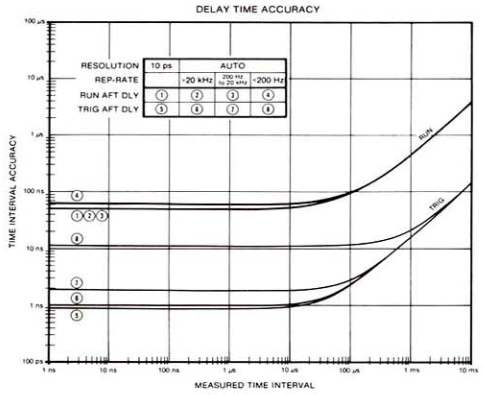
**TRIG AFT DLY Accuracy** — ±(LSD +0.001% of reading +0.5 ns +A trigger slew error +B trigger slew error). Add 0.5 ns for dual channel measurements.

Where: Trigger slew error equals trigger level control readout accuracy ÷ trigger signal slew rate at the trigger point.

When measured using word recognizer on the B Trigger: Add 100 ns using external clock; add 200 ns without external clock.

**RUN AFT DLY Accuracy** — ±(LSD +0.0012 x A Sec/Div +0.03 x B Time/div +50 ns). (B Time/div includes 10X mag.)

If measured using word recognizer on the B Trigger: Add 100 ns using external clock; add 200 ns without external clock.




*Note:*
*Input Signal is five vertical div with a 2 ns risetime.*
*Measured times are four horizontal div.*
*TJE is negligible for Slew Rates >0.1 div/ns.*
*ΔTime-TRIG AFT DLY assumes visual superposition.*

**Display Update Rate** — Auto, twice per second or once for each sweep, whichever is slower. Depends on trigger and sweep rate for selectable resolution.

### LSD TABLE

| A Sec/Div | Selected Resolution | LSD |
|---|---|---|
| 10 ns to 1 s | AUTO | See Auto Resolution Chart Below |
| 10 ns to 5 μs | 10 ps<br>100 ps<br>1 ns | 10 ps<br>100 ps<br>1 ns |
| 10 μs to 50 μs | 10 ps or 100 ps<br>1 ns | 100 ps<br>1 ns |
| 100 μs to 500 μs | 10 ps to 1 ns | 1 ns |
| 1 ms to 5 ms | 10 ps to 1 ns | 10 ns |
| 10 ms to 50 ms | 10 ps to 1 ns | 100 ns |
| 100 ms to 500 ms | 10 ps to 1 ns | 1 μs |
| 1 s | 10 ps to 1 ns | 10 μs |

**Auto Resolution**

| A Sec/Div | Trigger Repetition Rate | LSD |
|---|---|---|
| 10 ns to 2 μs | >20 kHz | 100 ps |
| 10 ns to 2 μs | 200 Hz to 20 kHz | 1 ns |
| 5 μs to 200 μs | >200 Hz | 1 ns |
| 10 ns to 200 μs | <200 Hz | 10 ns |
| 500 μs to 5 ms | Any | 10 ns |
| 10 ms to 50 ms | Any | 100 ns |
| 100 ms to 500 ms | Any | 1 μs |
| 1 s | Any | 10 μs |

*Note: 2445 A Sec/Div settings range from 20 ns to 1 s.*
*2465 A Sec/Div settings range from 10 ns to 500 ms.*

### TOTALIZE

**Maximum Count** — To 9,999,999 events.

### DELAY BY EVENTS

**A or B Sweep** — The A trigger or 17-bit word recognizer defines start events. The B trigger or 17-bit word recognizer defines delay events. Maximum delay count up to 4,194,303. Minimum time from start event to any delay event ≥4 ns. Minimum pulse width ≥3.3 ns. With A sweep in the delayed by events mode, the B sweep is delayable by time.

### LOGIC TRIGGER

**Combination Trigger** — A sweep can be triggered from logical combinations of A and B triggers (A and B) or (A or B), or the word recognizer. B sweep can be triggered from the word recognizer. Minimum time to satisfy logic combinations ≥4 ns.

### WORD RECOGNIZER

**Input** — P6407 Word Recognizer Probe (010-6407-01), 17 bits plus clock. (No CRT display from P6407.)

| All Inputs | Threshold | Load | Safe Limit |
|---|---|---|---|
| Hi | <2.0 V | <20 μA | 5.5 V |
| Lo | >0.6 V | >−0.6 mA | −0.5 V |

**Display Radix** — Hexadecimal, octal, binary.

**Data Rate** — 0 MHz to ≥20 MHz with clock, 0 MHz to ≥10 MHz without clock.

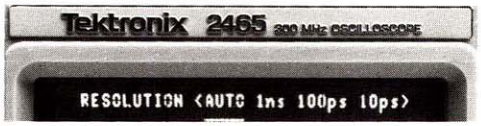
**Data Setup Time** — 25 ns.

**Data Hold Time** — 0 ns.

**GPIB Compatibility for Semiautomatic Measurement Systems** — When combined with Option 10 the CTT/WR (Option 09)/Oscilloscope combination is fully programmable. Complies with Tektronix *Standard Codes and Formats.*

### INCLUDED ACCESSORIES (Option 09)

In addition to the accessories listed for 2465 and 2445 instruments, a word recognizer probe (010-6407-01); 20 grabber tips (206-0222-00); two 10 inch 10 wide comb (012-0747-00); CTT/WR operator' manual; and CTT/WR reference card are provided.




## OPTION 06

### Counter/Timer/Trigger (CTT)

The Counter/Timer/Trigger is available without the word recognizer probe as Option 06. Specifications and included accessories (except WR probe) are the same as Option 09. The word recognizer cannot, however, be added to Option 06 after delivery (field retrofit kits are not available).

## OPTION 05

### TV Waveform Measurement System

**All of the High Performance Characteristics of Standard 2465/2445 Oscilloscopes Plus Television Waveform Analysis Capabilities**

**Selectable System-M and Nonsystem-M Protocols**

**Selectable Triggering on any Line with a Field, with Line-Number Readout**

**Compatible with Composite Video Having 13.1 kHz to 77 kHz Line Rates**

**TV Blanking-Level Clamp (Back-Porch)**

**Optimized Vertical Response Comparable to High Performance TV Waveform Monitors**

Option 05 extends 2465/2445 oscilloscopes to versatile television waveform measurement systems. Enhanced features make these instruments especially useful for testing and troubleshooting any equipment that combines raster display with video signals. Scopes equipped with Option 05 have practical application in virtually every stage of the product life cycle—design engineering, production lines, calibration facilities, QA areas, and service/maintenance functions.

NEW

*This sample waveform and CRT readout show a 2445's high-fidelity display of the Vertical Interval Reference Signal on Line 19, Field 1 with the television blanking-level clamp (TVC) engaged. The instrument used is also equipped with Option 10 (GPIB).*

Back-porch clamp circuitry delivers a stable display of composite video, even when signals are characterized by changing average picture level and low frequency hum.

Direct CRT readout of the triggering line number is a feature unique to Tektronix 2465/2445 oscilloscopes with Option 05. By eliminating operator line counting, we removed the uncertainty that is inherent with less-advanced oscilloscope television options.

New circuitry optimizes triggering on television signals. Any of four trigger coupling modes can be chosen to display desired portions of the composite signal—Lines, Field 1, Field 2, Field 1 alternating with Field 2.

## CHARACTERISTICS

The set of characteristics is the same as specified for standard 2465/2445 oscilloscopes and includes the following additions:

### VERTICAL DEFLECTION SYSTEM (CHANNEL 1 AND CHANNEL 2)

**Frequency Response** — For Volts/Div switch settings between 5 mV and 0.2 V with Var Volts/Div control in calibrated detent and using a 5-div, 50 kHz reference signal from a 50 Ω or 75 Ω system.

| | Frequency Reponse | |
|---|---|---|
| **Range** | **With Full BW** | **With BW Limiting** |
| 50 kHz to 5 MHz | ±1% | +1%, −4% |
| >5 MHz to 10 MHz | +1%, −2% | *1 |
| >10 MHz to 30 MHz | +2%, −3% | *1 |
| >30 MHz | *1 | *1 |

**1 Same as 2445/2465.*

**Squarewave Flatness** — 1% p-p for both 60 Hz and 15 kHz squarewaves, from a 50 Ω or 75 Ω system using a 1.0 V input with a 50 mV/div setting and using a 0.1 V input at 20 mV/div setting. 1.5% p-p using a 0.1 V input with 5 mV/div and 10 mV/div settings. Setup with 1 MΩ dc input coupling, external 50 Ω termination, Var Volts/Div control in calibrated detent, and fast-rise input signal (risetime ≤1 ns). Exclude first 50 ns following step transition. For signals with risetimes ≤10 ns, add 2% p-p between 155 ns and 165 ns after step transition.

**Television Blanking-Level Clamp (Back-Porch) 60 Hz Rejection (Channel 2 Only)** — ≥18 dB at 60 Hz; with calibrated Volts/Div settings between 5 mV and 0.2 V, and a 6-div reference signal.

**Television Blanking-Level Clamp (Back-Porch) Reference** — Within 1.0 div of ground reference.

### TRIGGERING

**Sync Separation** — Stable sync separation from sync-positive or sync-negative composite video on systems with 525 to 1280 lines/frame, 50 Hz or 60 Hz field rate, interlaced or noninterlaced scan.

**Trigger Modes** — LINES, FLD 1, FLD 2, and ALT (FLD 1-FLD 2) coupling.

**Input Signal Amplitude for Stable Triggering Channel 1 and Channel 2** — 1.0 div for composite video and 0.3 div for composite sync signals (dc + peak video-signal amplitude must be within 18 div of input ground reference).

**Channel 3 and Channel 4** — 0.5 div for composite video and 0.25 div for composite sync signals (dc peak video-signal amplitude must be within 9 div of input ground reference).

**GPIB Compatibility for Semiautomatic Measurement Systems** — When combined with Option 10, the TV Waveform Measurement Systems (Option 05)/oscilloscope combination is fully programmable. Complies with Tektronix *Standard Codes and Formats.*

### INCLUDED ACCESSORIES (Option 05)

In addition to the accessories listed for 2465 and 2445 instruments, a CCIR graticule CRT filter (378-0199-01); an NTSC graticule CRT filter (378-0199-02); a polarized collapsible viewing hood (016-0180-00); an operator's manual and reference guide are provided.

## ORDERING INFORMATION

**2465** 300 MHz Oscilloscope ..... **$5,150**
**2445** 150 MHz Oscilloscope ..... **$3,550**
**2465DVS** 300 MHz Oscilloscope [Includes DMM (Option 01), TV (Option 05), CCT/WR (Option 09), GPIB (Option 10), and two additional P6131 probes (Option 22). Provides most cost-effective combination of these options ..... **$8,550**
**2465DMS** 300 MHz Oscilloscope [Includes DMM (Option 01), CCT/WR (Option 09), GPIB (Option 10), and two additional P6131 probes (Option 22). Provides most cost-effective combination of these options ..... **$7,850**
**2465CTS** 300 MHz Oscilloscope [Includes CCT/WR (Option 09), GPIB (Option 10), and two additional P6131 probes (Option 22). Provides most cost-effective combination of these options ..... **$6,650**

### INSTRUMENT OPTIONS

**Option 01*3** — Digital Multimeter ..... +$1,500
**Option 05** — TV Waveform Measurement System . +$1,050
**Option 06*2** — Counter/Timer/Trigger ..... +$1,000
**Option 09*1*2** — CTT/Word Recognizer ..... +$1,400
**Option 10** — GPIB Interface ..... +$900

### MULTIPLE OPTION ALLOWANCE (MOA)

When a 2465 or 2445 is ordered with more than two of the above options, a special price allowance is applied. This allowance is not applicable to the 2465DVS, 2465DMS, or the 2465CTS specially priced edition.

**Option 2A** — MOA for combining two of the above options ..... −$300
**Option 3A** — MOA for combining three of the above options ..... −$600
**Option 4A** — MOA for combining four of the above options ..... −$900

### OTHER INSTRUMENT OPTIONS

**Option 1R*3** — Configure Oscilloscope for Rackmount ..... +$305
**Option 11*1** — Rear Panel Probe Power ..... +$155
**Option 22** — Two additional P6131 Probes ..... +$250

**1 Option 11 may not be ordered with Option 09 or the 2445.*
**2 Option 09 includes Option 06.*
**3 Option 1R may not be ordered with Option 01. For rackmounting Option 01, 2465DVS, and 2465DMS contact your Tektronix Sales Office.*
*NOTE: Options 01, 05, 06, 09, and 10 are not retrofitable with field upgrade kits.*

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

### *WARRANTY-PLUS* SERVICE PLANS—REFER TO PAGE 15

**M1** — (2465 and Special Editions) 2 Calibrations ..... +$265
**M1** — (2445) 2 Calibrations ..... +$255
**M2** — (2465 and Special Editions) 2 Years Service .... +$270
**M2** — (2445) 2 Years Service ..... +$215
**M3** — (2465 and Special Editions) 2 Years Service and 4 Calibrations ..... +$695
**M3** — (2445) 2 Years Service and 4 Calibrations ..... +$645
**M4** — (2465 and Special Editions) 5 Calibrations ..... +$670
**M4** — (2445) 5 Calibrations ..... +$660
**M5** — (2465 and Special Editions) 9 Calibrations +2 Years Service ..... +$1,350
**M5** — (2445) 9 Calibrations +2 Years Service ..... +$1,295

*Rackmont 2465 Option1R comes complete with slide-out chassis tracks.*

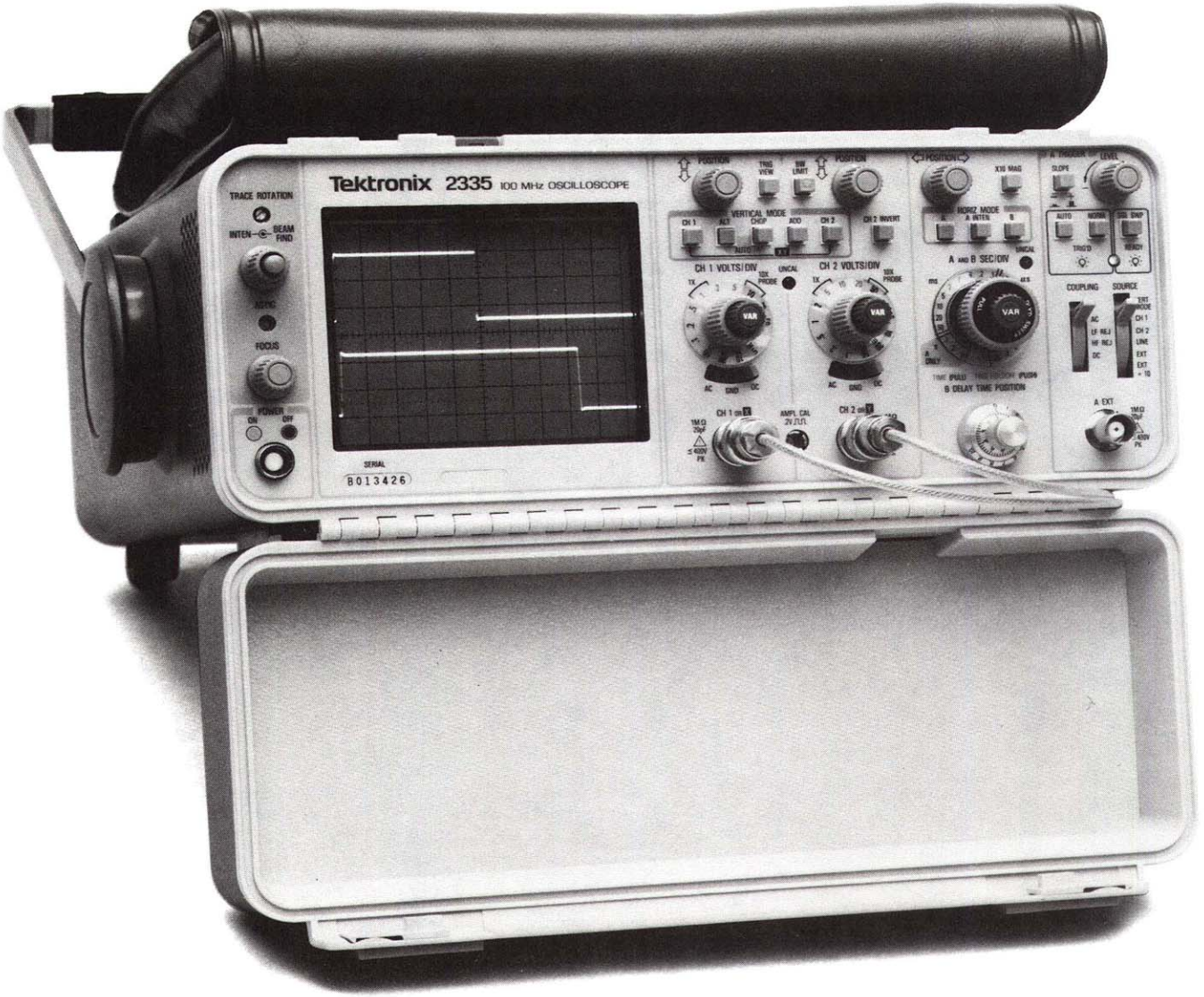
### OPTIONAL ACCESSORIES

**Rackmounting Conversion Kit** — Not compatible with Option 01. Order 016-0691-01 ..... **$305**
**Probe Power Extender Cable for Rackmount 2465 Option 11** — Order 020-0104-00 ..... **$210**
**Word Recognizer Extender Cable for Rackmount 2445/2465 Option 09 and 2465CTS.**
**GPIB Cable** — 1 m double shield, low EMC. Order 012-0991-01 ..... **$135**
**GPIB Cable** — 2 m double shield, low EMC. Order 012-0991-00 ..... **$150**
**Polarized Collapsible Viewing Hood** — Order 016-0180-00 ..... **$40**
**Folding Light Shield Viewing Hood** — Order 016-0592-00 ..... **$12**
**Folding Binocular Viewing Hood** — Order 016-0566-00 **$15**
**Protective Waterproof Blue Vinyl Cover** — Order 016-0720-00 ..... **$20**
**Carrying Case** — Order 016-0792-00 ..... **$295**
**Carry Strap** — Order 346-0199-00 ..... **$15**
**Camera** — See C-30B Option 01 or C-4. For more information see page 420.
**SCOPE-MOBILE Cart** — See K117 or K212 on page 429.
**Dc Power** — Order 1107 Dc Inverter. For more information see page 302 ..... **$950**
**P6131 Probe Package** — For use with Channel 3 or Channel 4. Order 010-6131-01 ..... **$140**
**P6230** — 10X Bias/Offset Probe. Order 010-6230-01 ..... **$395**
**Current Probes** — See P6021, P6022, A6302, A6303. For more information see pages 447 and 446 respectively.

**Service Manuals:**
**2445** — Order 070-3829-00 ..... **$20**
**2465** — Order 070-3831-00 ..... **$20**
**Option 01** — Order 070-4182-00 ..... **$10**
**Option 05** — Order 070-4630-00 ..... **$10**
**Option 06/09**
**Option 10** — Order 070-4640-00 ..... **$15**

**Additional accessories begin on page 417.**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**




## 2335/2336/2336YA/2337

**Dc to 100 MHz Bandwidth**

**5 mV/div to 5 V/div**

**5 ns/div Sweep Rate**

**Rugged for Field Service**

**Three Year Warranty—Five Year Option**

Compact and lightweight for ultra-portability, these oscilloscopes are designed and built for on-site trouble-shooting. The 2335, 2336, 2336YA and 2337 are useful for high speed logic and digital applications. They feature an innovative and protective flip-top cover that doubles as a front panel with ΔTime on the 2336, 2336YA and ΔTime/DMM on the 2337 versions. The entire outside case of all four instruments is made of durable, one-piece aluminum and the front panels are coated with scratch resistant plastic. When the flip-tops are latched shut, the entire scope can withstand the abuse and heavy usage of field service environments.

Vertical channels have calibrated deflection factors from 5 mV/div to 5 V/div with a variable gain control to increase the sensitivity to at least 2 mV/div. An internal delay line permits observation of the leading edge of a waveform. Variable sweep speeds range from 0.5 s/div to 50.0 ns/div and a 10X magnifier can increase the sweep rate to 5 ns/div. An auto-trigger mode allows triggering on waveforms with repetitive rates down to approximately 10 Hz. The sweep rate will run freely and provide a base line trace in the absence of an adequate trigger signal.

Many exterior features have been incorporated into these new ultra-portable scopes to make them fast and convenient to use. The CRT produces bright, high resolution traces that are readily visible in most light conditions. The ΔTime/DMM readouts are distinct, backlighted LCD (Liquid Crystal Displays) for clear viewing in any lighting condition. All knobs and switches have been located in logical groupings to avoid errors and delays during operation. And for the 2336, 2336YA and 2337 models, ΔTiming and DMM display and controls are in the hinged, fliptop cover.

All four oscilloscopes come with detachable power cord, integral EMI shielding, and an accessories pouch. They are manufactured to withstand impact shocks of 50 g's, almost twice that of other portable scopes from Tektronix. This ruggedness meets MIL-T-28800, Class 3 environmental requirements for aerospace and military qualification.

In strong testimony of the incomparable reliability of the 2000 Family oscilloscopes, Tek offers a three year warranty: All labor and parts, including CRT, excluding probes. And then, beyond the "basic three years" of warranty coverage, Tek will extend your service coverage up to five years, offering you a choice of three practical service plans to meet your specific service needs.

The 2336YA version of the standard 2336 100 MHz Portable Oscilloscope has a 5000 hour elapsed time indicator installed, and also includes additional accessories and an extra set of manuals. The 2336YA has been accepted and specified by the U.S. Navy.

### CHARACTERISTICS

The following characteristics are common to the 2335, 2336, 2236YA, and 2337 Oscilloscopes except where indicated.

**VERTICAL DEFLECTION (TWO IDENTICAL CHANNELS)**

**Bandwidth*1 and Risetime**

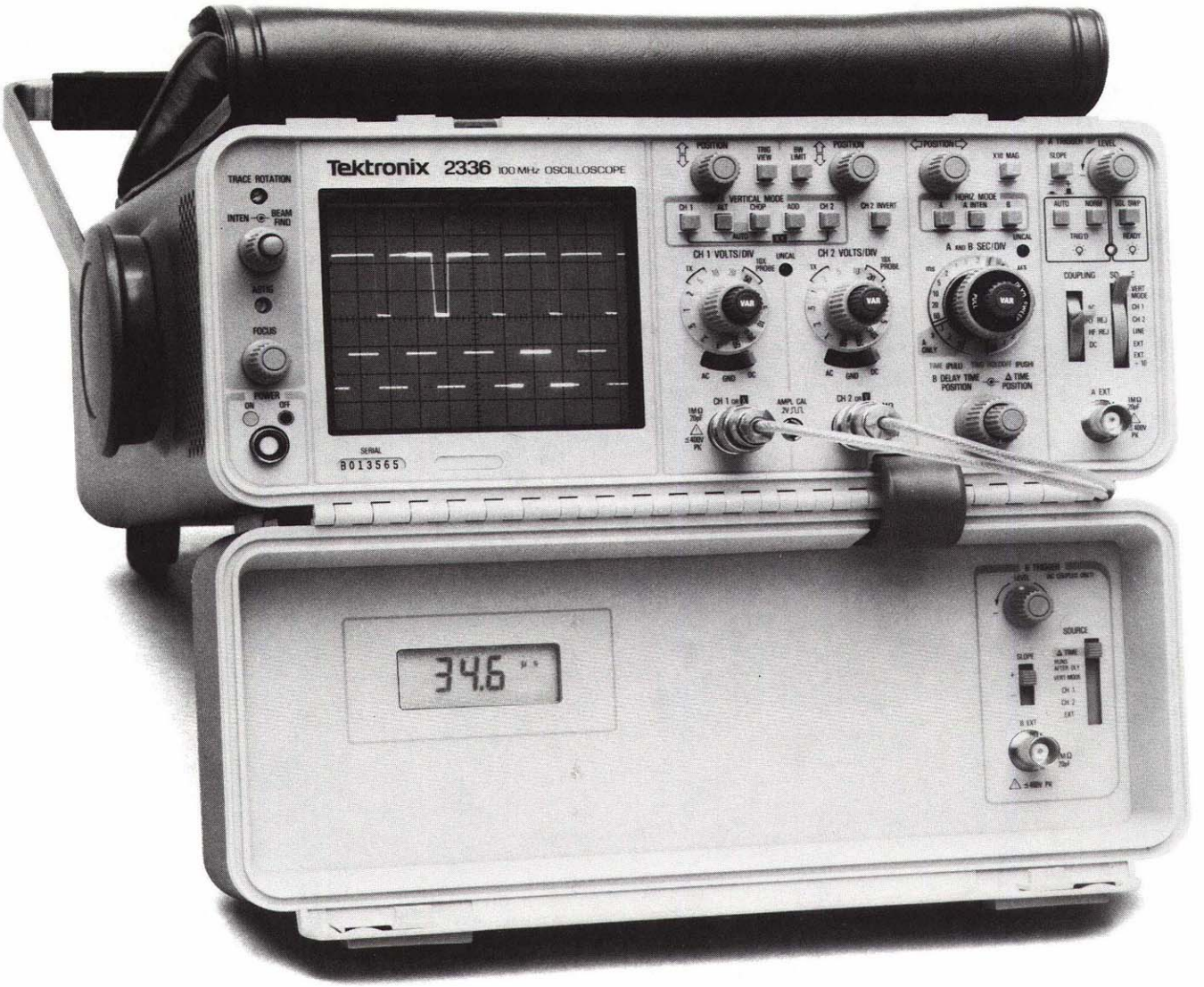
| −15°C to +40°C | +40°C to +55°C |
|---|---|
| Dc to at least 100 MHz, 3.5 ns | Dc to at least 85 MHz, 4.15 ns |

*1 *Measured at −3 dB point at all deflection factors from a 50-Ω source terminated in 50 Ω. Bandwidth may be limited to ≈20 MHz by bandwidth limit switch.*

**Lower −3 dB Point (Ac Coupling) 1X Probe** — 10 Hz or less; 10X Probe: 1 Hz or less.

**Deflection Factor** — 5 mV/div to 5 V/div. 1-2-5 sequence, accurate ±3%. Uncalibrated, continuously variable between steps and to at least 2 mV/div.

**Display Modes** — CH 1, CH 2, Add CH 2 (normal and inverted), alternate, chopped (≈275 kHz rate).




**Common-Mode Rejection Ratio** — At least 10:1 at 50 MHz for common-mode signals of 6 div or less.
**Input R and C** — 1 MΩ ±2% paralleled by 20 pF ±10%.
**Maximum Input Voltage** — Ac or dc coupled, 400 V (dc + peak ac) or 500 V p-p ac at 1 kHz or less.

### HORIZONTAL DEFLECTION

**Time Base A** — 0.05 μs/div to 0.5 s/div (1-2-5 sequence). X10 magnified extends maximum sweep rate to 5 ns/div.
**Time Base B** — 0.05 μs/div to 50 ms/div (1-2-5 sequence). X10 magnified extends maximum sweep rate to 5 ns/div.
**Variable Time Control** — Time base A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div.
**Time Base A and B Accuracy**[*1]

| | +20°C to +30°C | −15°C to +55°C |
|---|---|---|
| Unmagnified | ±2% | ±3% |
| Magnified | ±3% | ±4% |

*[*1] Full 10 divisions*
**Display Modes** — A, A intensified by B, B delayed.

### CALIBRATED SWEEP DELAY

**Delay Time Range** — Continuous from 50 ns to at least 5 s after start of delaying sweep.
**Differential Time Measurement Accuracy**

| | +15°C to +35°C | −15°C to +55°C |
|---|---|---|
| 2335 | 0.75% +0.015 major dial div | 1.5% +0.015 major dial div |
| 2336/2336YA /2337 | ±1% of reading ±1 count | ±2.5% of reading ±1 count |

**Jitter** — 1 part or less in 20,000 (0.005%) of 10 times the A Sweep Time/Div setting.

### TRIGGERING

**A Trigger Mode** — Normal (sweep runs when triggered). Automatic (sweep free runs in absence of a triggering signal and for signals below 30 Hz). Single Sweep (sweep runs once on first triggering event after reset selector is pressed). LED indicates when sweep is triggered and when single sweep is ready.
**Sensitivity and Coupling**

| Coupling | To 25 MHz | At 100 MHz |
|---|---|---|
| Dc Internal | 0.3 div deflection | 1.5 div deflection |
| Dc External | 50 mV | 150 mV |
| Dc External ÷ 10 | 500 mV | 1.5 V |
| Ac | Requirements increase below 60 Hz | |
| Ac LF Reject | Requirements increase below 50 kHz | |
| Ac HF Reject | Requirements increase above 50 kHz | |

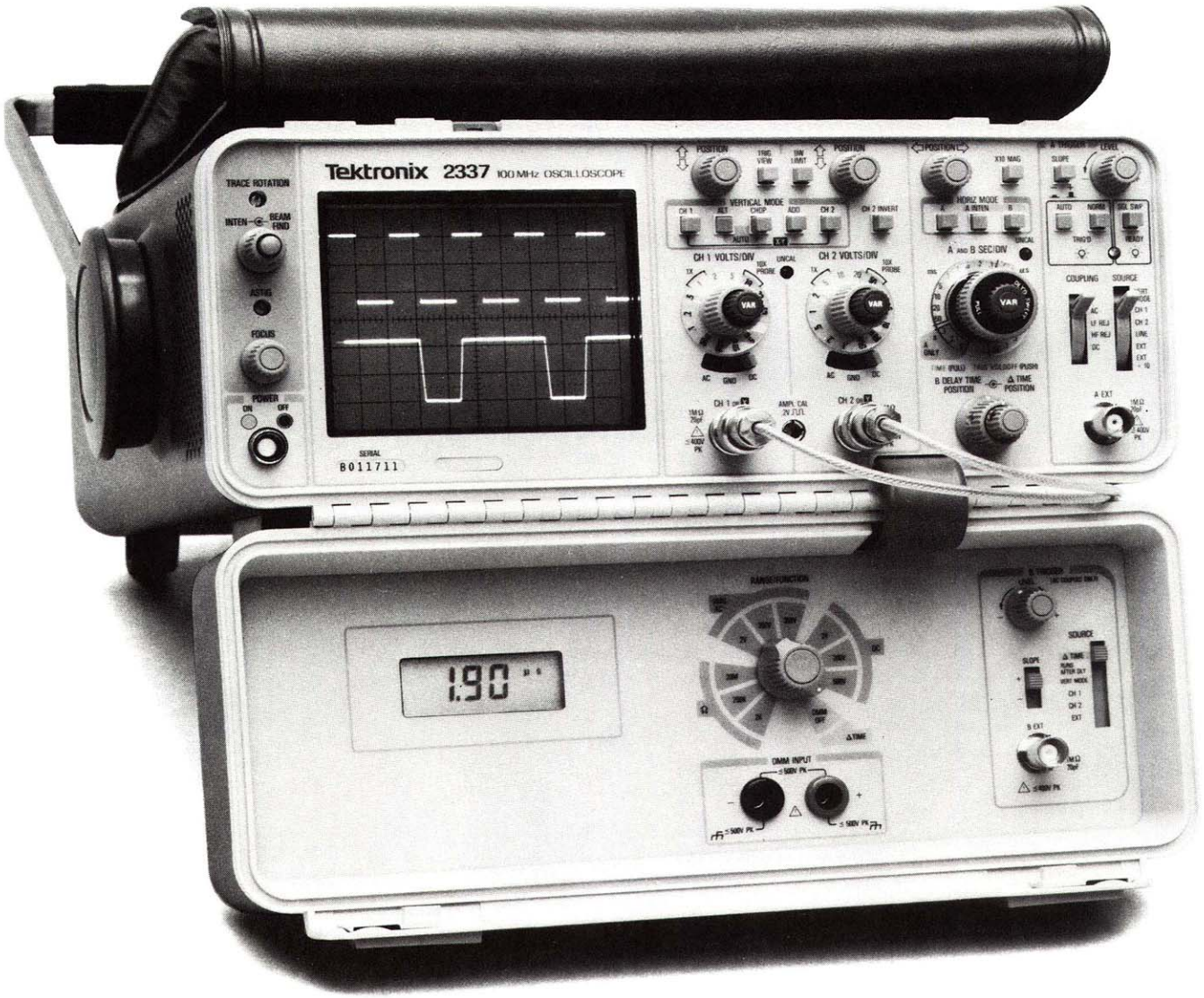
**A Trigger Hold Off** — Adjustable control permits a stable presentation of repetitive waveforms.
**ΔTime B Trigger Modes (2336, 2336YA and 2337 Only)** — Provides two intensified zones on the CRT trace for differential time measurements. Time difference between the two intensified zones is determined by B Delay Time Position and ΔTime Position controls, and is displayed on the LCD readout.
**Runs After Delay** — B Sweep starts immediately after the delay time selected by the Delay Time Position control and is independent of B trigger signal.
**Triggerable After Adjustable Delay Time** — The B Sweep Trigger is sourced from a composite of CH 1 and CH 2; CH 1 only, 2 only or from the Ext Trigger input connector.
**Jitter** — 1.0 ns or less at 100 MHz and 5 ns/div.
**A Trigger View** — A spring loaded pushbutton overrides other vertical controls to display the signal used to trigger the A Sweep. This control provides quick verification of the (trigger) signal and permits a time comparison between the vertical input signal and the trigger signal. Deflection Factor is 100 mV/div ±40% (1 V/div with Ext ÷ 10).
**Level and Slope** — Internal, permits selection of triggering at any point on positive or negative slope of vertical input signal. Level adjustment through at least ±1 V in Ext, through at least ±10 V in Ext ÷ 10.
**A Sources** — Vertical Mode, CH 1, CH 2, Line, Ext, Ext ÷ 10.
**B Sources (2336, 2336YA and 2337 Only)** — ΔTime runs after delay, Vertical Mode, CH 1, CH 2, Ext (all modes ac coupled).
**External Inputs** — R and C 1 MΩ ±10%, 20 pF ±30%. 400 V (dc + peak ac) or 500 V ac p-p at 1 kHz or less.

### X-Y OPERATION

**Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical)** — 5 mV/div to 5 V/div (1-2-5 sequence), accurate ±5% from 0°C to +40°C, accurate ±8% from −15°C to +55°C. X-axis bandwidth is dc to at least 2 MHz. Y-axis bandwidth is dc to at least 100 MHz. Phase difference between amplifiers is 3° or less from dc to 200 kHz.

### DISPLAY

**CRT** — 8 x 10 div (8 mm/div) display. Horizontal and vertical centerlines further marked in 0.2 div increments. GH (P31) Phosphor standard. 18 kV accelerating potential.
**Graticule** — Internal, nonparallax, nonilluminated; markings for measurement of risetime.
**Beam Finder** — Compresses trace to within graticule area to locate an off screen signal.
**Z-Axis Input** — Positive-going, dc coupled signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 20 MHz.




## 2337 with DIGITAL MULTIMETER

### DC VOLTAGE

**Full Scale Ranges** — 2 V (autoranging to 200 mV); 200 V (autoranging to 20 V); and 500 V.
**Resolution** — 100 μV at 200 mV full scale.
**Accuracy**

| | |
|---|---|
| +15°C to +35°C | Within ±0.15% of reading ±1 count |
| −15°C to +15°C | Add 0.01% for every °C below +15°C |
| +35°C to +55°C | Add ±0.01% for every °C above +35°C |
| >80% Relative Humidity | Add ±0.25% of reading ±3 counts |

**Input Resistance** — 10 MΩ ±0.25%.
**Rejection Ratio** — Normal-Mode: 60 dB minutes at 50 Hz and 60 Hz. Common-Mode: 100 dB minutes at dc, 60 dB minutes at 50 Hz and 60 Hz.
**Response Time** — Within 3 s (no autorange); within 9 s (up range); within 7 s (down range).
**Maximum Input Voltage** — 500 V (dc + peak ac) at 60 Hz (between positive and negative inputs or between either input and ground).

### AC VOLTAGE

**Full Scale Ranges** — 2 V (autoranging to 200 mV); 200 V (autoranging to 20 V); and 350 V.
**Crest Factor** — (When peak voltage input is <3 times full scale) Six.
**Accuracy**[*1]

| | |
|---|---|
| +15°C to +35°C | Within ±3%, ±6 counts[*1], 20 Hz to 20 kHz |
| −15°C to +15°C | Add ±0.05% for every °C below +15°C |
| +35°C to +55°C | Add ±0.05% for every °C above +35°C |

*[*1] Nonsinewaves: Derate below 50 Hz. For crest factors >3, add +0, −1% of reading.*

**Input Impedance** — Resistance 10 MΩ ±0.25% in series with input blocking cap. Capacitance (20 V, 200 V, and 350 V range) <150 pF; (200 mV, 2 V range) <220 pF.
**Common-Mode Rejection Ratio** — 60 dB minimum at 50 Hz and 60 Hz, 2 V range; 53 dB minimum at 50 Hz and 60 Hz, 200 V and 300 V range.
**Response Time** — Within 3 s (no autorange); within 9 s (up range); within 7 s (down range).
**Maximum Input Voltage** — 500 V (dc + peak ac) at 60 Hz (between positive and negative inputs or between either input and ground).

### RESISTANCE

**Full Scale Ranges** — 2 kΩ (autoranging to 200 Ω); 200 kΩ (autoranging to 20 kΩ); 20 MΩ (autoranging to 2 MΩ).
**Resolution** — 0.1 Ω.
**Accuracy**

| | |
|---|---|
| +15°C to +35°C | Within ±0.5% ±1 count +0.4 Ω |
| −15°C to +15°C | Add 0.05% for every °C below +15°C |
| +35°C to +55°C | Add 0.05% for every °C above +35°C |
| >80% Relative Humidity | Add ±1% of reading ±8 counts |

**Response Time** — <4 s.
**Maximum Input Voltage** — 500 V (dc + peak ac) at 60 Hz (between positive and negative inputs or between either input and ground).

### 2335, 2336, 2336YA, 2337 ENVIRONMENTAL CAPABILITIES[*1]

**Operating Temperature Range** — −15°C to +55°C (forced air ventilation during normal operation).
**Operating Temperature Range, Rackadapted (2335 Option 1R Only)** — Temperature inside equipment rack must be between −15°C and +55°C. 2335 exhaust fan temperature must not exceed +65°C.
**Storage Temperature Range** —
2335: −62°C to +85°C.
2236 and 2237: −40°C to +80°C.

**Altitude** — Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).
**Vibration (Structural Integrity)** — Test samples were subjected to sinusoidal vibration in the X, Y, and Z-axes with the frequency varied from 10 Hz to 55 Hz to 10 Hz in 1 minute cycles for a duration of 15 minutes. Total displacement was 0.025 in p-p at (4 g's at 55 Hz).
**Shock** — Operating and Nonoperating: Test samples were subjected to 3 shocks, both directions along each axis (X, Y, and Z) for a total of 18 shocks. Peak acceleration of each shock was 50 g's, ½ sine.
**Humidity** —
2335 (Operating and Nonoperating): Test samples were exposed to 120 hrs (5 cycles) of 95% relative humidity as specified in MIL-T-28800B Paragraph 3.9.2.2.
2336, 2336YA and 2337 Oscilloscope (Operating): Test samples were subjected to 90% relative humidity at 55°C for a maximum of 72 hours.
2336, 2336YA and 2337 DMM (Operating): Test samples were subjected to 90% relative humidity at 35°C for a maximum of 24 hours and to 70% relative humidity at 50°C for a maximum of 24 hours.
2336, 2336YA and 2337 Oscilloscope and DMM (Nonoperating): Test samples were subjected to 90% relative humidity at 60°C for 72 hours.
**Electromagnetic Compatibility (EMC)** — Test samples were found in compliance with the Class 3 requirements of MIL-STD-461A using procedural steps outlined in MIL-STD-462. (Increase RS03 requirements from 1 V/m to 10 V/m) for REO1, use 500 Hz to 30 kHz in place of 30 Hz to 30 kHz.)

*[*1] The 2335 Oscilloscope meets all environmental requirements of MIL-T-28800, Class 3. The 2336, 2336YA and 2337 Oscilloscopes meet the environmental requirements of MIL-T-28800, Class 3 except as indicated herein to avoid potential damage to the LCD readout.*

### OTHER CHARACTERISTICS

**Amplitude Calibrator** — 0.2 V accurate ±1% from 0°C to +40°C, ±1.5% from −15°C to +55°C.

**Power Requirements** — Quick-change selector for operation from 100 V to 132 V ac or 200 V to 250 V ac, 48 Hz to 440 Hz. Maximum power consumption is 60 W at 132 V, 48 Hz. Typical power consumption is 35 W at 115 V, 60 Hz. Option 03 provides operation from 90 V to 115 V ac or 180 V to 230 V ac, 48 Hz to 440 Hz.

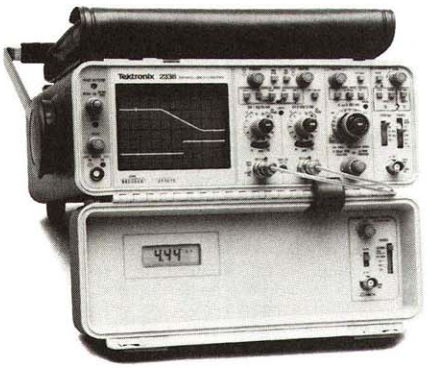
### PHYSICAL CHARACTERISTICS

| 2337 | 2335,2336,2336YA, Cabinet | | 2335 Option 1R Rackmount | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 274 | 10.8 | 483 | 19.0 |
| (with handle) | 315 | 12.4 | | |
| Height | | | 133 | 5.2 |
| (with feet/pouch) | 210 | 8.3 | | |
| (without pouch) | 135 | 5.3 | | |
| Depth | | | 378 | 14.9 |
| (with front cover) | 430 | 17.0 | | |
| (handle extended) | 528 | 20.8 | | |
| **Weights (2335)** | **kg** | **lb** | **kg** | **lb** |
| Net (without accessories or pouch) | 7.7 | 17.0 | 11.7 | 25.8 |
| Net (with accessories and pouch) | 8.6 | 19.0 | 12.6 | 27.8 |
| Shipping | 10.6 | 23.5 | 16.9 | 37.3 |
| **Weights (2336,2336YA,2337)** | **kg** | **lb** | **kg** | **lb** |
| Net (without accessories and pouch) | 8.0 | 17.6 | | |
| Net (with accessories and pouch) | 8.9 | 19.6 | | |
| Shipping | 10.9 | 24.1 | | |

**INCLUDED ACCESSORIES (2335, 2336, 2336YA 2337)**

Two P6108 10X Probes (010-6108-03); accessory pouch (016-0674-00); zip lock accessory pouch (016-0537-00); installed, blue CRT implosion shield (337-2760-00); clear CRT implosion shield (337-2781-00); two 1A fuses (159-0022-00); ½ A fuse (159-0025-00); power cord (161-0104-00). 2337 also includes test lead pair (012-0941-00); operator's manual.

*Rackmount 2335 Option 1R*



*2336YA*

*The 2336YA has been accepted and specified by the U.S. Navy.*

**INCLUDED ACCESSORIES (2336YA)**

P6101 1X Probe (010-6101-03); two P6108 10X Probes (010-6108-03); three probe tip adaptors (103-0051-01); three springtip adaptors (206-0060-00); zip lock accessory pouch (016-0537-00); accessory pouch (016-0674-00); installed, blue CRT implosion shield (337-2760-00); clear CRT implosion shield (337-2781-00); two 1A fuses (159-0022-00); ½ A fuse (159-0025-00); power cord (161-0104-00); two operator's manuals; two service manuals.

### ORDERING INFORMATION

**2335** Oscilloscope ..... **$2,900**
**2336** Oscilloscope with ΔTime ..... **$3,200**
**2336YA** Oscilloscope with ΔTime, Elapsed Time Meter, Extra Accessories and Manuals ..... **$3,275**
**2337** Oscilloscope with ΔTime and DMM ..... **$3,600**
**Option 1R** — Rack Conversion (2335 Only) ..... +**$305**
**Option 03** — 100 V/200 V, ac nominal, 48 Hz to 440 Hz . **NC**

### INTERNATIONAL POWER CORDS & PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz

***WARRANTY-PLUS* SERVICE PLANS—REFER TO PAGE 15**

**M1** — (2335) 2 Calibrations ..... +**$145**
**M1** — (2336/2336YA) 2 Calibrations ..... +**$160**
**M1** — (2337) 2 Calibrations ..... +**$180**
**M2** — (2335) +2 Years Service ..... +**$140**
**M2** — (2336/2336YA) +2 Years Service ..... +**$160**
**M2** — (2337) +2 Years Service ..... +**$180**
**M3** — (2335) +2 Years Service & 4 Calibrations ..... +**$410**
**M3** — (2336/2336YA) 2 Years Service & 4 Calibrations ..... +**$470**
**M3** — (2337) 2 Years Service & 4 Calibrations ..... +**$510**
**M4** — (2335) 5 Calibrations ..... +**$390**
**M4** — (2336/2336YA) 5 Calibrations ..... +**$445**
**M4** — (2337) 5 Calibrations ..... +**$480**
**M5** — (2335) 9 Calibrations +2 Years Service ..... +**$825**
**M5** — (2336/2336YA) 9 Calibrations +2 Years Service ..... +**$940**
**M5** — (2337) 9 Calibrations +2 Years Service ..... +**$1,025**

### OPTIONAL ACCESSORIES

**P6122** — 10X Passive Probe Order 010-6122-01 ..... **$77**
See probe section for additional probes.

**Camera** — C-5C Option 04 (includes 016-0359-01 adaptor and flash) ..... **$495**

**Rackmounting Conversion Kit** — (For 2335 only.) Order 016-0468-00 ..... **$250**

**K212 Portable Instrument Cart** — For on-site portability **$330**

**K117 Instrument Shuttle** — For site-to-site portability . **$265**

**See page 429 for complete description on carts.**

**A6902A Isolator** — For floating measurements see page 434 for complete description. Order A6902A ..... **$1,985**

## 1105 BATTERY POWER SUPPLY

The 1105 is a rugged, portable power supply suitable for powering virtually any portable oscilloscope in the field. The 1105 is not recommended for the T912.

### CHARACTERISTICS

**Frequency** — Squarewave, 60 Hz ±10%.

**Amplitude** — ≈108 V peak, operating from 24 V dc external or 22 V internal charge. ≈137.5 V peak, operating from 28 V dc external or 30 V internal charge.

**Amplitude (Option 01)** — ≈216 V peak, from 24 V dc external or 22 V internal charge. ≈275 V peak, operating from 30 V dc external or 28 V internal charge.

**Charging Power Source** — 100 V to 132 V ac, 48 Hz to 440 Hz (or internal connections expand range). Option 01: −200 V ac to 264 V ac, 48 Hz to 440 Hz (or internal connections expand range).

**Battery Operating Time** — ≈100 W hours.

**Recommended Maximum Output Current** — 0.9 A.

**Weight** — 8.8 kg (19.5 lb).

### ORDERING INFORMATION

**1105** Battery Power Supply ..... **$1,550**
**Option 01** — 230 V Operation ..... **NC**

## 1106 BATTERY PACK

The 1106 is a convenient, snap-on battery power supply for Tektronix 464 or 466 ocilloscopes when the scope is ordered with Option 07. The 1106 is used in combination with the 1107 DC Inverter with the 2000 Family oscilloscopes.*1

### CHARACTERISTICS

**Output Power** — 22 V to 26 V dc; 100 W-hours from full charge.

**Charging Power Source** — 90 V to 132 V ac, 50 Hz to 400 Hz; or 180 V to 264 V ac, 50 Hz to 400 Hz.

**Charging Time** — 14 hours to 16 hours.

**Weight** — 7.2 kg (16 lb).

### ORDERING INFORMATION

**1106** Battery Pack ..... **$1,150**
**1106 to 2400 Series Attachment Kit.**
Order kit 016-0797-00 ..... **$50**

**1 Please note that with 12 V input and certain 2445/2465 option combinations, operation may be limited.*

*The 1106 with attachment kit fits under the base of a scope. The 1107 attaches with kit to the rear of a scope.*

## *NEW* 1107 DC INVERTER

The 1107 is a rugged, portable dc inverter designed to interface virtually any 2000 Family*1 portable oscilloscope to a dc power source. The 1107 is used in combination with the 1106 Battery Pack with 2000 Family oscilloscopes*2. A special hardware package is available to attach the 1106 to 2400 Series oscilloscopes.

### CHARACTERISTICS

**Frequency** — ≈60 Hz ac.

**Amplitude** — 115 V ac (≈165 V peak).

**Efficiency** — ≈80% at 80 W.

**Weight** — ≈3.5 lbs.

**Size** — ≈11x3x5 inches.

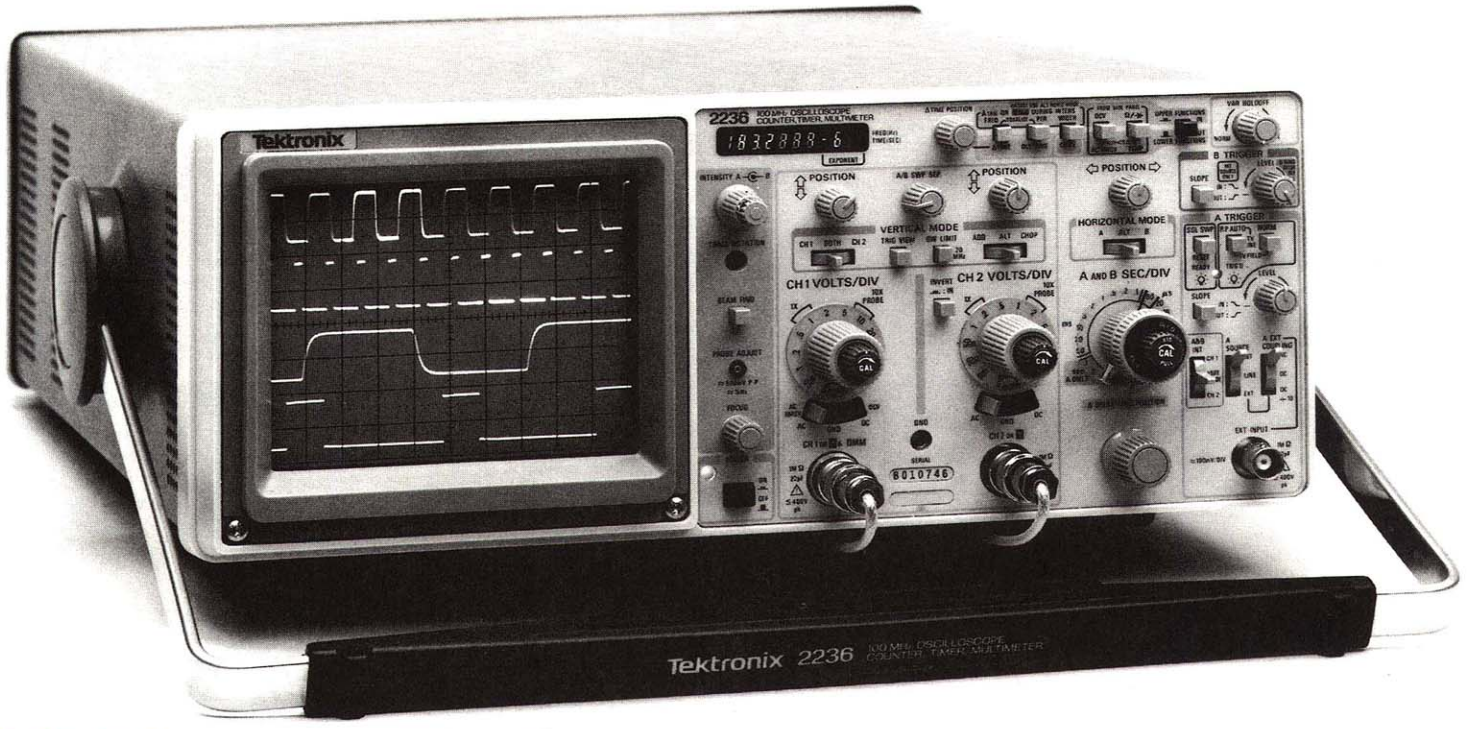
### ORDERING INFORMATION

**1107** Dc Inverter ..... **$950**
**1107 to 2200 Series Attachment Kit.**
Order kit 016-0785-00 ..... **$50**
**1107 to 2300 Series Attachment Kit.**
Order kit 016-0786-00 ..... **$50**
**1107 to 2400 Series Attachment Kit.**
Order kit 016-0783-00 ..... **$50**
**1106 to 2400 Series Attachment Kit.**
Order kit 016-0797-00 ..... **$50**

**1 Certain early 2200 Series scopes may not be compatible with the 1107 unless they have Option 48 installed.*

**2 Please note, that with 12 V input and certain 2445/2465 option combinations, operation may be limited.*

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**




## 2235/2236

- Dc to 100 MHz Bandwidth
- Integrated Counter/Timer/DMM (2236)
- Light Weight
- Easy to Use
- 2 mV Sensitivity
- Advanced Trigger System
- 5 ns/div Sweep Rate
- Delayed Sweep Measurements
- Large, Bright CRT
- 10X Probes Included
- Three Year Warranty—Five Year Option

With the 2235 and 2236 oscilloscopes, Tektronix takes the high-value, high-performance design concept of the 2200 Series even further. Both scopes feature a low price made possible by the 2200 Series' innovative architecture. Yet both scopes offer advanced performance, operational simplicity and—not least—solid reliability. All backed by a three-year warranty on all parts and labor, including the CRT, excluding probes.

The 100 MHz 2236 introduces a new concept in waveform measurement: a 100 MHz counter/timer/DMM, integrated into the scope's vertical, horizontal and trigger systems. Its capabilities simplify setup, heighten measurement confidence and expand scope versatility in innumerable ways. In one application after another, the 2236 replaces mental gymnastics and roundabout problem-solving with simple, direct, accurate, digital readouts that supplement your analog measurements.

**The TEK 2236**

The Tek 2236 provides easy, accurate, and versatile measurements through microprocessor-driven waveform analysis. While it's not unusual for a scope to include a bolt-on DMM or other outboard peripheral, the 2236 makes counter/timer/DMM-type measurements through the scope system itself. This convenient feature allows the user to make consolidated setups and combinations of measurements that have always been desirable but never before possible.

Traditionally, for example, gated measurements have been possible only by laborious knob-tweaking and mental calculations. Getting results was difficult at best.

But with the 2236, an operator uses intensified markers on-screen to define the area to be measured on a burst or short-duration pulse train. Gated counter measurements are made via the B trigger with operator prompting and automatic, digital readout of results. (See Figures 1, 2, 3). With period averaging the 2236 can make low frequency measurements instantly, in contrast to the several seconds delay encountered on conventional counter/timers.

Yet speed never comes at the expense of reliability: user confidence is continually enhanced.

The scope and DMM also can be applied simultaneously, with concurrent CRT and digital readout displays. The same probe that feeds data to the scope also provides information to the DMM, so there's no tangle of leads, no extra setup time required to obtain true ac RMS or dc voltage readings (see Figure 6).

DMM auto ranging simplifies setup. An ohmmeter range of 2 GΩ—a hundred times the range of most such devices—lets the service technician quickly pinpoint even small amounts of transformer leakage, for example, or allows designers to check the insulating property of capacitors more accurately than ever before (see Figure 9).

Designers and service people can both do a lot with the 2236, without learning a lot to do it. Frequency, period and width measurements are push-button simple, with accuracies to 0.001% and beyond. On-screen operator prompts further ensure fail-safe setup (see Figure 7).

An audible, automatic diode/junction detection, and continuity signal saves both time and interpretation errors by allowing the operator to concentrate on probing rather than on observing the front panel (see Figure 8).

Using the 100 MHz, microprocessor-controlled 2236, autoaveraged and autoranged counter/timer measurements are made on the signal triggering the A sweep, or in gated modes on the signal triggering the B sweep. Autoranged DMM measurements are made through floating DMM side inputs and up-range at 5000 counts. Channel 1 voltage measurements made on Channel 1 signal include: dc, relative dc, relative and true ac RMS voltage. Counter/timer/multimeter measurements are displayed on a 9-digit, 7-segment vacuum-fluorescent panel in engineering notation; audible signals supplement the resistance and continuity measurement messages. Self-testing includes power-on and user interactive routines.

The 2236 is designed for wide appeal by providing the power to simplify routine service measurements, and at the same time encouraging sophisticated designers towards creative methods of problem-solving.

In strong testimony of the incomparable reliability of the 2000 Family of oscilloscopes, Tek offers a three year warranty: All labor and parts, including CRT, excluding probes. And then, beyond the "basic three years" of warranty coverage, Tek will extend your service coverage up to five years, offering you a choice of three practical service plans to meet your specific service needs.

## Gated Frequency Measurement

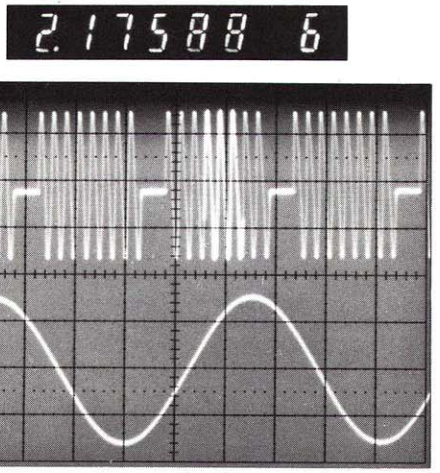



*Figure 1*
*With the B sweep triggered, the frequency within the intensified zone on the A sweep is measured.*

## Gated Period Measurement

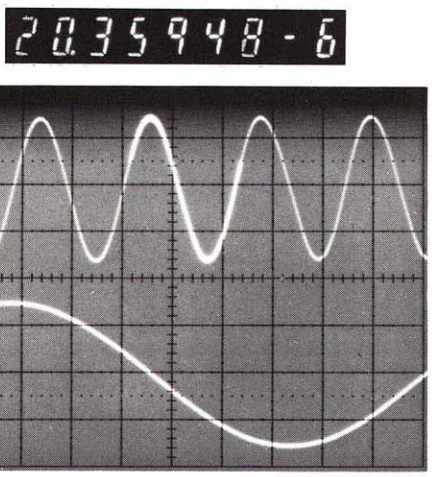



*Figure 2*
*With the B sweep triggered, the period within the intensified zone on the A sweep is measured.*

## Gated Width Measurement

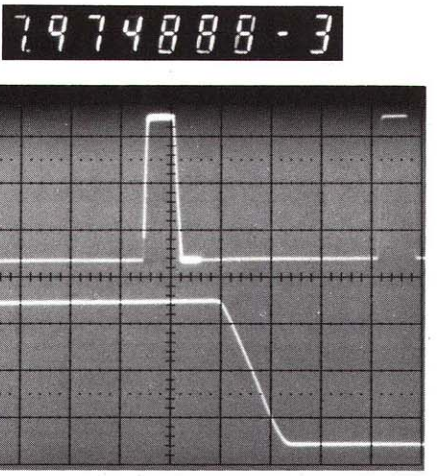



*Figure 3*
*With the B sweep triggered, the width to be measure is within the intensified zone and polarity is selected by the B trigger slope control.*

## Gated Totalize Measurement

*With the B sweep triggered, the events within the intensified portion of the A sweep are totalized.*

## Delay Time Measurement

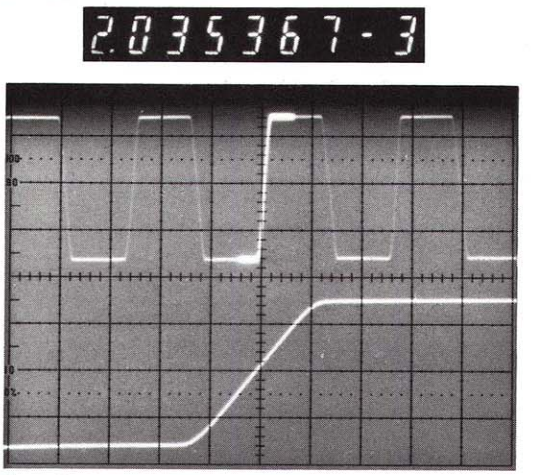



*Figure 4*
*Delay time is measured from the start of the A sweep to the start of the intensified zone.*

## Delta Time Measurement

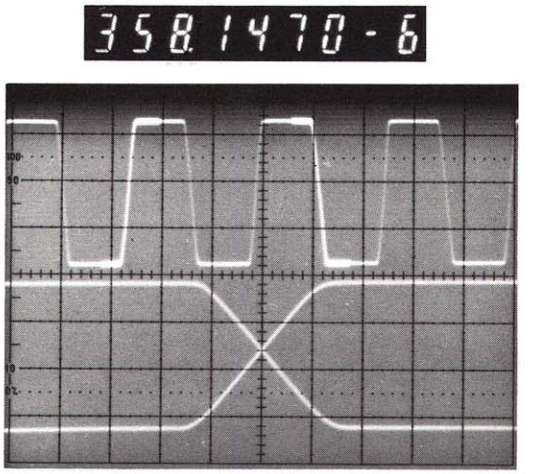



*Figure 5*
*The time between the two intensified zones on the A sweep is measured with up to 10-picosecond resolution.*

## Channel 1 Volts Measurement

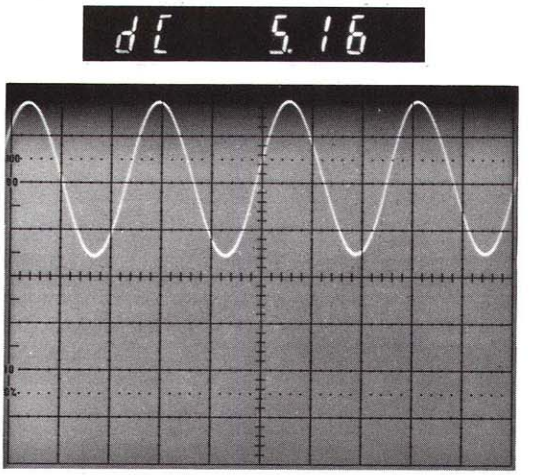



*Figure 6*
*The average dc or true ac RMS component of a waveform is measured directly through channel 1 or from the floating DMM input.*

## Continuity Measurement

*Resistances >5 Ω, the message "OPEN" is displayed. <5 Ω, a tone is generated and the message "SHORT" is displayed.*

## Operator Prompting

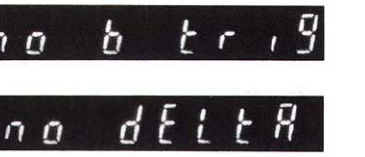



*Figure 7*
*Error messages and prompts make counter-/timer/DMM measurements easier.*

## Diode Detection and Test

*Figure 8*
*Automatic junction detection during normal resistance measurements first displays "DIODE" and then the forward voltage drop to 1%.*

## Extended Range Resistance Measurement

*Figure 9*
*0 Ω (with 0.01 Ω resolution) to 1.99 GΩ, to find hard-to-trace problems like leaky caps or bad transformers.*

## Temperature Measurement

*With optional P6602 Probe: From −62° C to +230° C (−80° F to +446° F); resolution to 0.1° (either range).*

## Microprocessor Diagnostics

*Automatic power-up and user-interactive diagnostic routines simplify CTM service.*

## Accurate Time Measurement

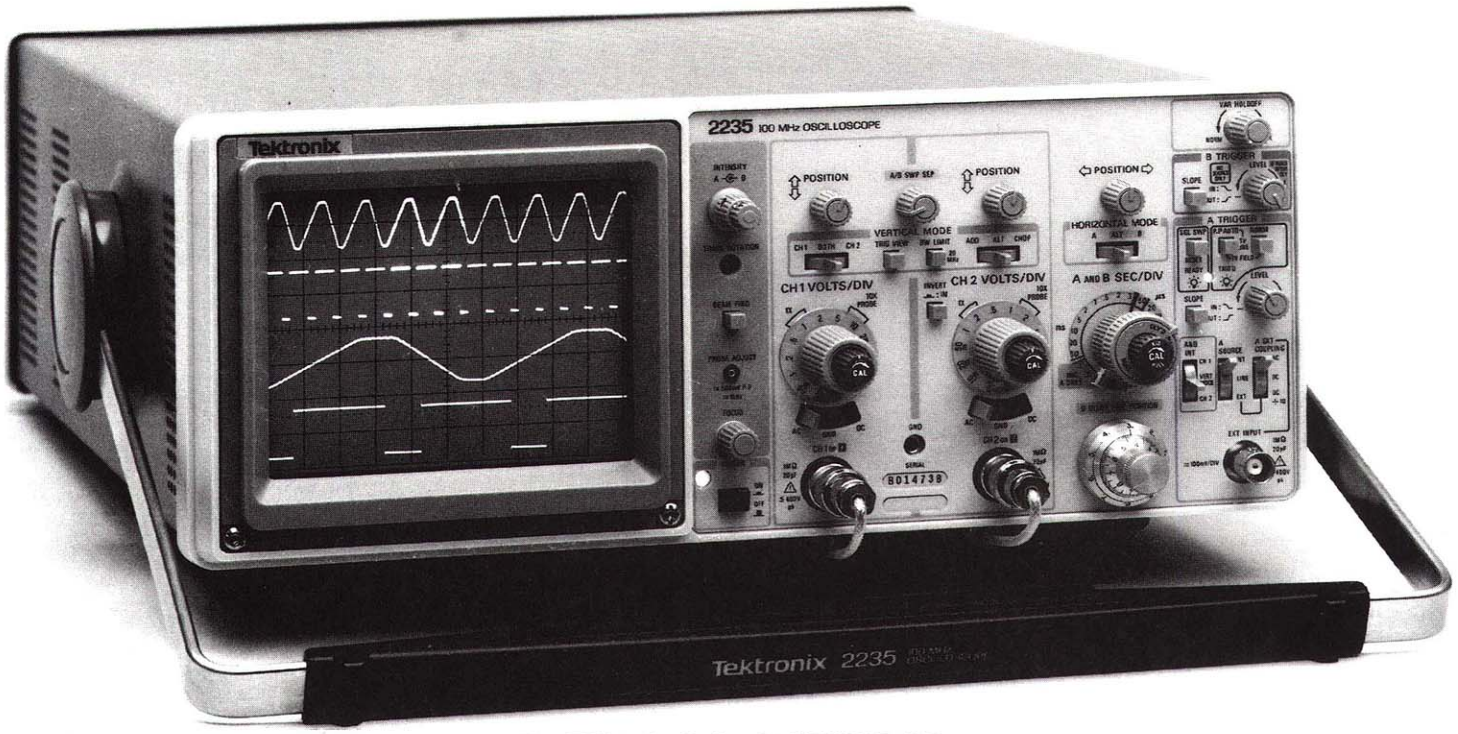
*Time base error only 10 ppm (0.001%) standard, and only 0.5 ppm (0.00005%) with optional temperature compensated crystal oscillator.*

## Measurement Ease and Accuracy

*See the measurement you make on the CRT, read the result with digital accuracy on the 9-digit display.*

**For further information and specifications see page 305.**

NEW




**The TEK 2235**
The 2235 ensures measurement quality and reliability while reducing instrument cost. Tek started with the innovative architecture of the 2200 Series: fewer boards, fewer mechanical parts, less cabling and electrical connectors. This approach, plus advanced circuit design and a focus on essential features, has led to a scope that's more accurate, more reliable, lighter and more serviceable—and simpler to use—than any other 100 MHz scope.

The 2235 delivers 2% vertical and horizontal accuracy in normal operation. Accuracy of 3% or better is maintained across a wide range of environmental extremes. Trace noise, chop noise, vertical aberrations and sweep interference have been reduced to a minimum. Delay jitter of 1:20,000 ensures excellent timing measurement resolution. Triggering is sensitive to 0.3 div at 10 MHz. There's a trigger view for simplifying setup; single sweep for photographing transients; bandwidth limit for noisy environments; and a bright, high-resolution 14 kV dome mesh CRT.

Features like rugged design, light weight and an easy-to-learn front panel make the 2235 an ideal service scope. In both service and design, it offers the sensitivity for low level measurements and sweep rates for fast logic families, plus 10:1 variable holdoff range for complex word triggering. And at the bottom line, it offers the price and reliability to significantly lower the cost of owning a quality scope.

## *NEW* 2235 Option 01 (AN/USM-488)

**Fully Provisioned Through the U.S. Army System**

**Meets or Exceeds MIL-T-28800C**

**Dc to 100 MHz Bandwidth**

**Accepted and Specified by the U.S. Army**

**The TEK 2235 Option 01 (AN/USM-488)**
The 2235 Option 01 is accepted and specified by the U.S. Army. If you're involved in designing and specifying systems for the U.S. Army, here is a 100 MHz oscilloscope that should top your support equipment lists.

Comparable in performance to the standard 2235, the 2235 Option 01 version has impressive features. It meets the rigid environmental requirements of MIL-T-28800C for Class 5 instruments. Electromagnetic interference is improved over the standard 2235, and meets MIL-STD-461B part 4 requirements. It has adjustable graticule illumination as well as uncalibrated indicator lights for both the horizontal time base and the vertical channels. HF REJ and LF REJ filtering expand flexibility for trigger coupling.

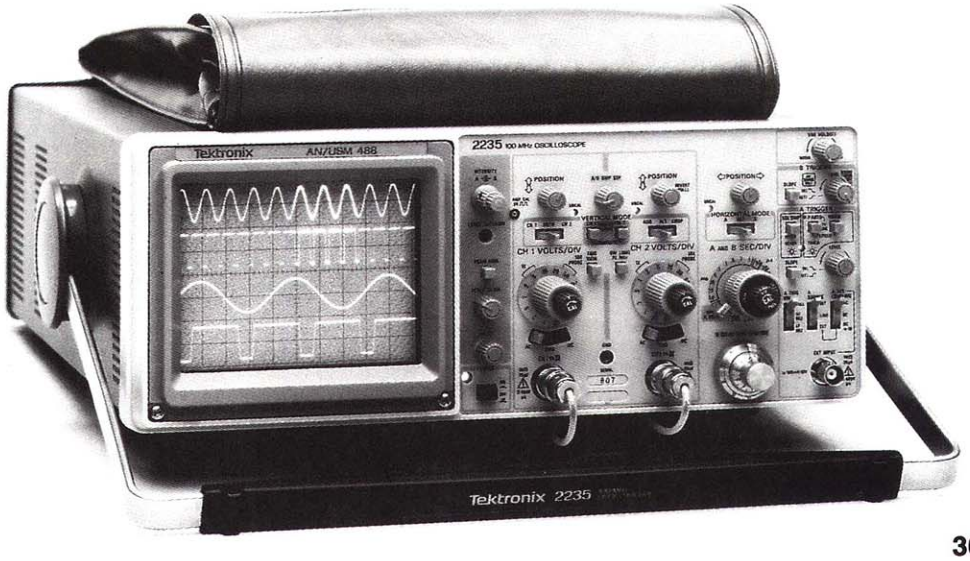
For your convenience we've also included a protective front-panel cover, cord wrap/storage pouch, P6101 1X 2-meter probe, BNC T connector, BNC male-to-binding post, two IC grabber tips and a service manual.

## CHARACTERISTICS

The following electrical characteristics are common to the 2236, 2235, 2235 Option 01 except where noted.

**VERTICAL SYSTEM**
**(TWO IDENTICAL CHANNELS)**

**Bandwidth (−3 dB) and Risetime** — 100 MHz and 3.5 ns, derated to 90 MHz at 2 mV/div and outside 0°C to +35°C. Bandwidth Limit: 20 MHz ±10%.
**Deflection Factor** — 2 mV to 5 V/div at ±2%. Accuracy derated to ±3% outside +15°C to +35°C (+10°C to +35°C 2235 Option 01. Uncalibrated: Continuously variable between steps by at least 2.5:1.
**Step Response Aberrations** —
2235 and 2235 Option 01: +4%, −4%, 4% p-p (2 mV to 0.5 V/div), +12%, −12%, 12% p-p (1 V to 5 V/div).
2236: +5%, −5%, 5% p-p (2 mV/div), +4%, −4%, 4% p-p (5 mV to 0.5 V/div), +14%, −14%, 14% p-p (1 V to 5 V/div).
**Vertical System Operating Modes** — CH 1, CH 2, CH 2 Invert, Add, Alt, Chop (500 kHz).
**Common-Mode Rejection Ratio** — For signals of 6 divisions or less, at least 10:1 @ 50 MHz. (10:1 @ 80 MHz 2235 Option 01).
**Input R and C** — 2235 and 2235 Option 01: 1 MΩ, 20 pF.
2236: 1 MΩ, 22 pF.
**Maximum Input Voltage (Ac and Dc Coupled)** — 400 V (dc + peak ac) or 800 V (p-p to 10 kHz).
**Channel 1/Channel 2 Isolation** — 100:1 at 50 MHz.
**Trace Shift** — ≤0.75 div with V/div switch rotation, ≤1 div with V/div variable, ≤1.5 div with CH 2 Invert.



### HORIZONTAL SYSTEM

**Sweep Rate** — A Time Base: 0.05 μs to 0.5 s/div in 1-2-5 sequence. 10X Mag: 5 ns/div. B Time Base: 0.05 μs to 50 ms/div in 1-2-5 sequence. 10X Mag: 5 ns/div.
**Sweep Linearity** — ±5% over any two of center 8 divisions.
**Accuracy** — Magnified: ±3%. Unmagnified: ±2%. Derated outside +15°C to +35°C (+10°C to +35°C 2235 Option 01).
**Horizontal Operating Modes** — A, alternate (A intensified by B), B.

### DELAYED SWEEP

**Delay Times** — Continuously variable with 10-turn control from <0.5 +300 ns to >10 divisions.
**Differential Delay Dial Accuracy (2235 and 2235 Option 01)** — ±1% (+15°C to +35°C).
**ΔTime Measurement Accuracy (2236)** — Max accuracy equal to time base accuracy ±50 ps. Time Base Accuracy With Standard Oscillator: 10 ppm (0.001%); with Option 14 TCXO (Temperature-Compensated Crystal Oscillator): 0.5 ppm (0.00005%).
**Delay Jitter** — 2236: 10,000:1 (0.01%). 2235 and 2235 Option 01: 20,000:1 (0.005%).

### TRIGGER SYSTEM

**A Trigger Sensitivity**

| 2235 & 2235 Opt 01 | Internal | External (p-p volts) |
|---|---|---|
| 10 MHz | 0.3 div | 35 mV |
| 100 MHz (2235) | 1.5 div | 200 mV |
| 100 MHz (2235 Opt 01) | 1.5 div | 150 mV |
| **2236** | | |
| 10 MHz | 0.35 div | 40 mV |
| 100 MHz | 1.5 div | 250 mV |
| **2236 CTM** | | |
| 10 MHz | 0.5 div | 50 mV |
| 100 MHz | 2.0 div | 300 mV |

**B Trigger (Internal Only) Sensitivity**

| | 10 MHz | 100 MHz |
|---|---|---|
| 2235 & 2235 Opt 01 | 0.35 div | 1.5 div |
| 2236 | 0.4 div | 1.5 div |
| 2236 CTM | 0.5 div | 2.0 div |

**High Frequency Reject (2235 Option 01 Only)** — Attenuates signals above 40 kHz.
**Low Frequency Reject (2235 Option 01 Only)** — Attenuates signals below 40 kHz.
**Trigger System Operating Modes** — Normal, p-p automatic, TV field, and single sweep. Bandwidth Limit: 20 MHz ±10%.
**Trigger View System** — Same deflection factors as vertical channels with internal sources; 100 mV/div with ac and dc external, and 1 V/div with dc ÷ 10 external. Accuracy is ±20%. Delay difference between trigger view and either vertical channel is <2.0 ns.
**External Trigger Input** — Coupling: Ac, dc, or dc ÷ 10.
**Variable Holdoff Control** — Increases A sweep holdoff time at least 10:1.

### X-Y MEASUREMENTS

**Deflection Factors** — Same as scope's vertical system with the V/div switch in calibrated detent.
**Accuracy**

| | Y-Axis | X-Axis |
|---|---|---|
| +15°C to +35°C | ±2% | ±3% |
| 0°C to +50°C | ±3% | ±4% |

**Bandwidth** — Y-Axis: same as scope's vertical system. X-Axis: 2.5 MHz.
**Phase Difference Between X-Axis and Y-Axis Amplifiers** — ±3° from dc to 150 kHz with dc coupled inputs.

### DISPLAY

**CRT** — 8 x 10 cm display; internal graticule, unilluminated GH (P31) phosphor is standard; 14 kV nominal voltage.
**Controls** — Beam finder, focus, separate A and B sweep intensity, trace rotation.
**Z-Axis** — Sensitivity: 5 V cause noticeable modulation, positive voltage decreases intensity. Usable frequency range is dc to 20 MHz.

### ENVIRONMENTAL CHARACTERISTICS

**Temperature** — Operating: 0°C to +50°C, (except 2236 CTM ac RMSV, DCV, and Ω Modes: 0°C to +40°C). Nonoperating: −55°C to +75°C.
**Humidity** — Operating and Nonoperating: 5 cycles (120 hours) referenced to MIL-T-28800C.
**Altitude** — Operating: To 4500 m (15,000 ft). Maximum operating temperature decreased 1°C/1,000 ft 5,000 ft to 15,000 ft. Nonoperating: To 15,000 m (50,000 ft).
**Shock** — Operating: 30 g's, ½ sine, 11 ms duration, 3 shocks per axis each direction for a total of 18 shocks.
**Vibration** — Operating test samples were subjected to sinusoidal vibration in the X, Y, and Z axis with the frequency varied from 10 Hz to 55 Hz to 10 Hz in 1 minute sweeps for a duration of 15 minutes per axis and a dwell of 10 minutes at 55 Hz. Total displacement was 0.015 in p-p (2.4 g's at 55 Hz).
**EMC** (2235 Option 01 AN/USM 488 Only): — Meets requirements of MIL STD-461B Part 4, CE03, CS01, CS02, CS06, RE02 (to 1 GHz), and RS03 (1 V/meter to 1 GHz).
All 2200 series instruments meet Class B requirements per VDE 0871 for radiated and conducted emission.

### OTHER CHARACTERISTICS

**Power** — Voltage: 90 V to 250 V ac. Frequency: 48 Hz to 440 Hz. Operation from 10 V to 30 V dc is available with Option 07. (No line switches or fuse changes needed.)
**Probe Adjust Signal** — Squarewave, 0.5 V ±5%, 1 kHz ±20% (2235, 2236).
**Amplitude Calibrator** — Squarewave, 0.5 V ±2%, 1 kHz ±20% (2235 Option 01 only).

## 2236 with Counter/Timer/Multimeter

### CHARACTERISTICS

**Time Base Accuracy** — Standard: 10 ppm (0.001%). With Option 14 TCXO: 0.5 ppm (0.00005%).

**Frequency** — Range: ≤0.2 Hz to ≥100 MHz. Maximum Resolution: 0.00001 Hz. Maximum Accuracy: Equal to time base accuracy. Can be gated.*1

**Period** — Range: ≥5 s to ≤10 ns. Maximum Resolution: 10 ps. Maximum Accuracy: Equal to time base accuracy. Can be gated.*1

**Width** — Range: ≥5 s to ≤5 ns. Maximum Resolution: 10 ps. Maximum Accuracy: Equal to time base accuracy ±10 ns. Can be gated.*1

**Delay Time** — Range: ≥2.5 s to ≤500 ns. Maximum Resolution: 10 ps. Maximum Accuracy: Equal to time base accuracy ±2 ns.

**Delta Time** — Range: ≥2.5 s to ≤1 ns. Maximum Resolution: 10 ps. Maximum Accuracy: Equal to time base accuracy ±50 ps.

**Totalize** — Over 8,000,000 events. Can be gated.*1

**Dc Volts** — Range: 0 V to 500 V. Maximum Resolution: 100 μV. Accuracy: ± 0.1%. Input: Through side DMM leads.

**RMS Ac Volts** — Ac Coupled: True RMS with 20 Hz to 20 kHz frequency range. Range: 0 V to 350 V. Maximum Resolution: 100 μV. Accuracy: ± 1.0%. Input: Through side DMM leads.

**CH 1 Volts** — Measures average dc voltage (with CH 1 dc coupling) or true RMS voltage (with CH 1 ac coupling); 1X/10X ranged by coded probes: Single Sweep button zeros display and permits relative dc and ac RMS measurements. Range, Dc and Ac Volts: 0 V to 50 V (500 V dc/350 V ac with P6121 10X Probe). Maximum Resolution, Dc and Ac Volts: 100 μV (1 mV with P6121). Maximum Accuracy, Dc Volts (18°C to 28°C): ±0.3% with 1X probe, ±0.5% with 10X probe. Maximum Accuracy, Ac Volts with 1X probe (18°C to 28°C): ±2%, 50 Hz to 100 Hz, ±1%, 100 Hz to 20 kHz. Maximum Accuracy, Ac Volts with 10X Probe: ±2%, 20 Hz to 20 kHz, with proper probe compensation.

**Resistance** — Range: 0 GΩ to 1.99 GΩ. Maximum Resolution: 0.01 Ω. Accuracy: To 0.15%. Automatic diode detection displays forward voltage drop to ±1%; continuity mode activates tone if resistance is <5 Ω.

**Temperature** — Uses Optional Tektronix P6602 Temperature Probe. Temperatures in C or F selected with Freq/ΔTime button. Range: −62°C to +230°C. Resolution: To 0.1° (either range). Accuracy: To ±2% of reading ±1.5°C; ±2% of reading ±2.70°F.

**Multimeter Inputs** — Isolated from oscilloscope ground. Input Z: 10 MΩ. Maximum Input Voltage: 500 V (dc + peak ac), for all functions.

**1 Ranges, resolutions, and accuracies can be degraded due to gating errors and a smaller number of automatic averages made during a gated frequency, period, or width measurement.*

### PHYSICAL CHARACTERISTICS

| | 2235 and 2235 Opt 01 | | 2236 | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width*1 | 328 | 12.9 | 328 | 12.9 |
| Height | 137 | 5.4 | 137 | 5.4 |
| Depth*2 | 440 | 17.3 | 440 | 17.3 |
| **Weights ≈** | **kg** | **lb** | **kg** | **lb** |
| Net | 6.1 | 13.5 | 7.3 | 16.2 |

**1 Without handle.* **2 Without front cover.*

**INCLUDED ACCESSORIES (2235)**
Two P6122 10X voltage probes (010-6122-01); operator's manual; service manual optional.

**INCLUDED ACCESSORIES (2235 Option 01)**
Two P6122 10X Voltage Probes (010-6122-01); P6101 1X Voltage Probe (010-6101-03); BNC T-connector; BNC male to binding post; front panel cover; accessory pouch; two grabber tips; operator's manual; service manual.

**INCLUDED ACCESSORIES (2236)**
Two P6121 10X voltage probes (010-6121-01); DMM leads; operator's manual; service manual optional.

### ORDERING INFORMATION

**2235** Oscilloscope ..... **$1,650**
**2235 Option 01** Oscilloscope (AN/USM-488) **Order 2235L** ..... **$1,995**
**2236** Oscilloscope with Counter/Timer/Multimeter ..... **$2,650**
**Option 14** — TCXO Temperature-Compensated Crystal Oscillator (2236 Only) ..... **+$295**
Impact resistant packaging is available. Contact your local Tektronix Sales Engineer for details.

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**
**Option A1** — Universal Euro 220 V/16 A, 50 Hz. Order 020-0859-00.
**Option A2** — UK 240 V/13 A, 50 Hz. Order 020-0860-00.
**Option A3** — Australian 240 V/10 A, 50 Hz. Order 020-0861-00.
**Option A4** — North American 240 V/15 A, 60 Hz. Order 020-0862-00.
**Option A5** — Switzerland 220 V/10 A, 50 Hz. Order 020-0863-00.

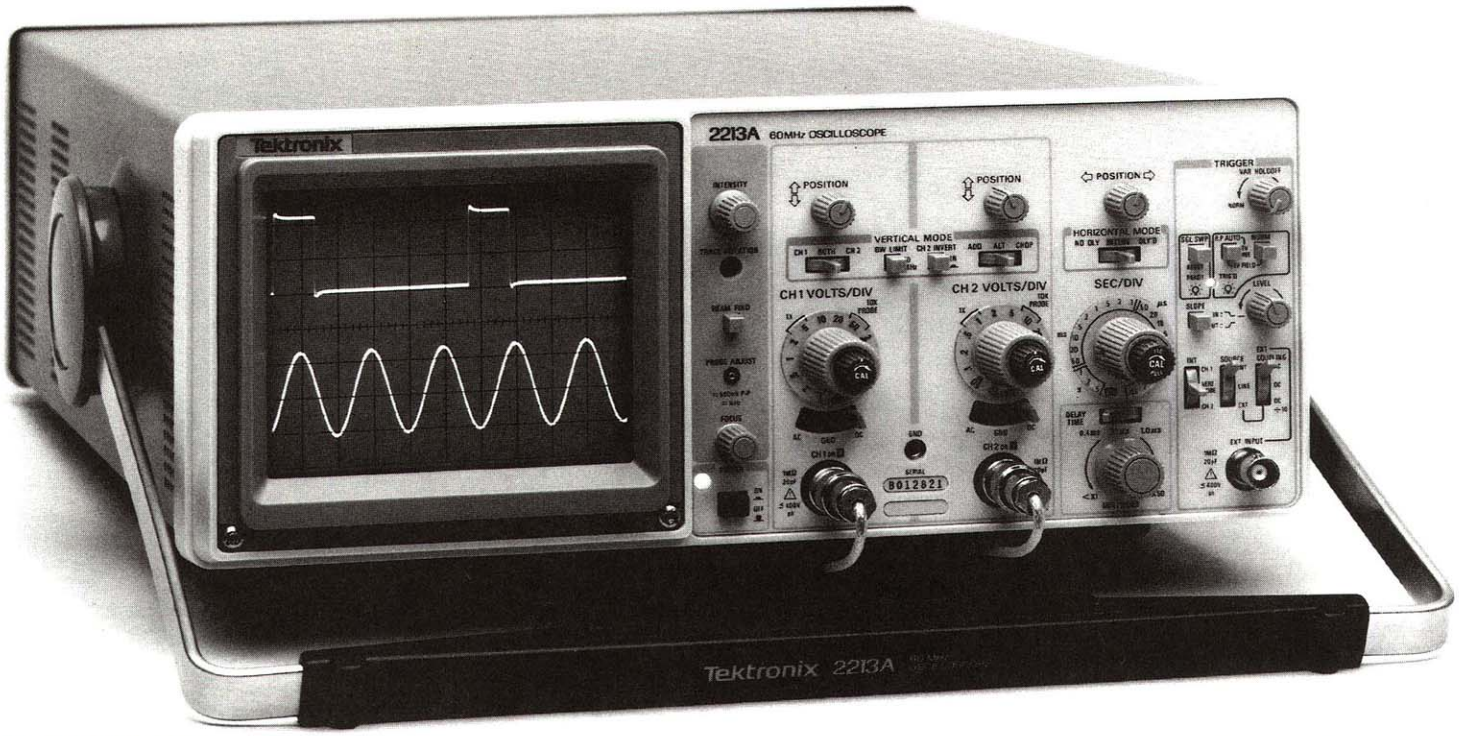
***WARRANTY-PLUS* SERVICE PLANS—REFER TO PAGE 15**
**M1** — (2235/2235 Option 01) 2 Calibrations ..... **+$135**
**M1** — (2236) 2 Calibrations ..... **+$160**
**M2** — (2235/2235 Option 01) +2 Years Service ..... **+$125**
**M2** — (2236) +2 Years Service ..... **+$150**
**M3** — (2235/2235 Option 01) 2 Years Service & 4 Calibrations ..... **+$380**
**M3** — (2236) 2 Years Service & 4 Calibrations ..... **+$450**
**M4** — (2235/2235 Option 01) 5 Calibrations ..... **+$385**
**M4** — (2236) 5 Calibrations ..... **+$425**
**M5** — (2235/2235 Option 01) 9 Calibrations +2 Years Service ..... **+$805**
**M5** — (2236) 9 Calibrations +2 Years Service ..... **+$900**

**OPTIONAL ACCESSORIES**
**Front Panel Cover and Accessory Pouch*1** — Order 020-0672-02 ..... **$47**
**Front Panel Cover*1** — Order 200-2520-00 ..... **$5.00**
**Accessory Pouch*1** — Order 016-0677-00 ..... **$42**
**Viewing Hood** — Order 016-0566-00 ..... **$15**
**Carrying Strap** — Order 346-0199-00 ..... **$15**
**Carrying Case** — Order 016-0792-00 ..... **$295**
**2235 Rack Adaptor Kit** — Order 016-0466-00 ..... **$100**
**2236 Rack Adaptor Kit** — Order 016-0015-00 ..... **$200**
**CRT Light Filter (Clear)*1** — Order 337-2775-00 ..... **$3.00**
**Camera C-5C** — Option 04 ..... **$495**
**K212 Portable Instrument Cart** — For on-site portability. ..... **$330**
**K117 Instrument Shuttle** — For site-to-site portability. **$265**
**See page 429 for complete description on carts.**
**A6902A Isolator** — For floating measurements see page 434 for complete description. Order A6902A ..... **$1,985**
**P6602 Temperature Probe** — For use with 2236 CTM. Order 010-6602-00 ..... **$225**
See probe section for additional probes.
**2235 Service Manual** — Order 070-4206-00 ..... **$25**
**2236 Service Manual** — Order 070-4204-00 ..... **$25**

**1 Standard with the 2235 Option 01 (AN/USM-488).*

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

NEW




## 2213A/2215A

**Dc to 60 MHz Bandwidth**

**Lightweight**

**Easy to Use**

**2 mV Sensitivity**

**Advanced Trigger System**

**5 ns/div Sweep Rate**

**Delayed Sweep Measurements**

**Large, Bright CRT**

**10X Probes Included**

**Three Year Warranty—Five Year Option**

Two new 60 MHz, dual trace oscilloscopes from Tektronix offer unprecedented value in both initial and life cycle costs. Beginning with the architecture developed for the 2235, the improvements found in that instrument have been incorporated into the 2213A and 2215A. This approach lead to improved specifications, even higher reliability and new features such as bandwidth limit, single sweep, and a bright 14 kV dome mesh CRT.

These oscilloscopes provide unexcelled performance in a small lightweight package; 6.1 kg (13.5 lb) 2215A; 5.8 kg (12.8 lb) 2213A.

X-Y operation is simple and easy to use. Both vertical input channels (CH 1 and CH 2) can be used through their full range of sensitivity settings. Vertical sensitivities range from 2 mV to 5 V/div. Sweep speeds range from 0.5 s/div to 50 ns/div. A 10X magnification provides 5 ns/div.

A pushbutton beamfinder allows easy scope set-ups. The scope bezel accepts a Tektronix C-5C Scope Camera with graticule illuminating flash (Option 04).

The advanced triggering system features true vertical mode alternate triggering; both the 2213A and 2215A will trigger alternately even with unrelated signals. Other features include variable trigger holdoff, TV line and TV field triggering at any sweep speed, and peak to peak auto mode. On the 2215A, the dual time base operates in either run after A or trigger after A. The latter permits jitter-free B measurements.

The 2213A's single time base delay provides the user with the performance of intensified and delayed sweep operations at a low price. Where dual time base performance is required, the 2215A delivers it with alternate sweep switching. The 2215A can display four traces; vertical channels 1 and 2 at the A sweep rate, and vertical channels 1 and 2, delayed, at the B sweep rate. The 2215A also has separate A and B intensity controls that provide convenient control over the A sweep, intensified zone, and B sweep.

Low life cycle cost is brought about by the inherent reliability of the new scopes. The parts count and cabling have been greatly reduced as compared to older designs. Even the traditional line transformer and line voltage selector switches have been eliminated, thanks to a new high-efficiency power supply. The advantages of these power supply improvements are that the 2213A and 2215A will operate from mains voltages of 90 V to 250 V RMS at frequencies from 48 Hz to 440 Hz. Additional reliability also results from superior mechanical design and packaging, soldered-in components, absolute minimum of connectors and very low power consumption.

In strong testimony of the incomparable reliability of the 2000 Family oscilloscopes, Tek offers a three year warranty. All labor and parts, including CRT, excluding probes. And then, beyond the "basic three years" of warranty coverage, Tek will extend your service coverage up to five years, offering you a choice of three practical service plans to meet your specific service needs.

## CHARACTERISTICS

The following electrical characteristics are common to both instruments except where noted:

### VERTICAL DEFLECTION (2 IDENTICAL CHANNELS)

**Bandwidth*1 and Risetime*2**

| 0°C to +40°C | +40°C to +50°C |
|---|---|
| Dc to 60 MHz, 5.8 ns<br>5 mV/div to 5 V/div | |
| Dc to 50 MHz, 7 ns<br>2 mV/div, | Dc to 50 MHz, 7 ns<br>2 mV/div to 5 V/div |

**1 Measured at −3 dB.*

**2 At all deflection factors from 50 Ω terminated source.*

**Bandwidth Limit** — 10 MHz ±15%.

**Deflection Factor** — 2 mV/div to 5 V/div ±3% (0°C to +50°C). 1-2-5 sequence. Uncalibrated, continuously variable between steps to at least 12.5 V/div.

**Display Modes** — CH 1, CH 2, CH 2 Add (normal and inverted), Alternate, Chopped: ≈500 kHz rate, electronically switched.

**Common-Mode Rejection Ratio** — At least 10:1 at 25 MHz for common-mode signals of 6 divisions or less.

**Input R and C** — 1 MΩ ±2% paralleled by 20 pF ±2 pF.

**Maximum Input Voltage**

| | |
|---|---|
| Ac Coupled and<br>Dc Coupled | 400 V (dc + peak ac)<br>800 V (p-p ac at 10 kHz or less) |

**Delay Line** — Permits viewing leading edge of displayed waveform.

### HORIZONTAL DEFLECTION

**Time Base A (2213A and 2215A)** — 0.05 μs/div to 0.5 s/div (1-2-5 sequence). 10X magnifier extends max sweep rate to 5 ns/div.

**Time Base B (2215A Only)** — 0.05 μs/div to 50 ms/div (1-2-5 sequence). 10X magnifier extends max sweep rate to 5 ns/div.

**Variable Time Control (2213A and 2215A)** — Time Base A provides continuously variable uncalibrated sweep rates between steps to at least 1.25 s/div.

**Time Base A (2213A and 2215A) and B (2215A Only) Accuracy*1**

| | +15°C to +35°C | 0°C to +50°C |
|---|---|---|
| **Unmagnified** | ±3% | ±4% |
| **Magnified** | ±4% | ±5% |

**1 Center 8 divisions.*

**Horizontal Display Modes (2213A)** — A, A intensified after delay, delayed.

**Horizontal Display Modes (2215A)** — A, alternate (A intensified by B and B), B. Electronic switching between intensified and delayed sweep.

### 2213A SWEEP DELAY

**Delay Times** — 1.0 μs, 20 μs, and 0.4 ms.

**Multiplier** — Increases delay time by 50 to 1 or more.

**Jitter** — 10,000 to 1 (0.01%) of maximum available delay time.

NEW

### 2215A SWEEP DELAY

**Delay Times** — Continuously variable by means of a 10 to 1 vernier control. Delayed (B) portion is intensified on the main (A) trace.

**Delay Position Range** — <0.5 div +300 ns to more than 10 div.

**Differential Time Measurement Accuracy** — ±1.0% (+15°C to +35°C) or ±2.0% (0°C to +50°C).

**A/B Sweep Separation** — Control permits main and delayed sweep to be separated ±3.5 div.

**Jitter** — 20,000 to 1 (0.005%) of maximum available delay time.

### TRIGGERING

**2213A and 2215A A Time Base Trigger Modes** — Normal (sweep runs when triggered), peak-to-peak automatic (sweep runs in the absence of a triggering signal and triggers automatically for signals down to 20 Hz), and TV field (with slope set for negative going transitions, and trigger level adjusted close to blanking level, sweep starts at first line of video; use peak-to-peak automatic for TV line display). LED indicates when sweep is triggered.

**A Trigger Holdoff** — Adjustable control permits a stable presentation of repetitive complex waveforms.

**Sensitivity** — Auto and Normal Internal: Below 5 MHz, signal must be at least 0.3 div amplitude; requirements increase above 5 MHz; at 60 MHz, signal must be at least 1.0 div amplitude.

**Auto and Normal External** — Up to 5 MHz, trigger signal must be at least 40 mV p-p; requirements increase up to 60 MHz, where signal must be at least 150 mV p-p.

**TV Field** — Composite sync must be at least 1.0 div amplitude.

**Level and Slope (Norm Mode)** — Internal: Trigger level can be adjusted over the range of amplitudes displayed on the CRT. External, Dc Coupled: Level can be adjusted over a range of at least ±1.6 V, or 3.2 V p-p. External, Dc Coupled and Attenuated (÷10): Level can be adjusted over a range of at least ±16 V, or 32 V p-p.

**External Inputs** — R and C ≈1 MΩ paralleled by 20 pF ±2.5 pF. 400 V (dc + peak ac) or 800 V ac p-p at 10 kHz or less.

### 2215A DELAYED (B) TIME BASE

**Level and Slope** — Separate slope and level controls for triggering B sweep.

**Sensitivity** — Up to 5 MHz, signal must be at least 0.4 div in vertical amplitude; requirements increase up to 60 MHz, where signal must be at least 1.5 div in amplitude.

### X-Y OPERATION

**Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical)** — 2 mV/div to 5 V/div, accurate ±4%. Bandwidth is dc to at least 2 MHz. Phase difference between amplifiers is 3° or less from dc to 100 kHz.

### DISPLAY

**CRT** — 8 x 10 cm display. Horizontal and vertical center lines further marked in 0.2 cm increments. GH (P31) Phosphor standard. 14 kV accelerating potential, mesh grid.

**Graticule** — Internal, nonparallax, not illuminated; markings for measurement of risetime.

**Beam Finder** — Compresses trace to within graticule area for ease in locating an off-screen signal. A preset intensity level provides a constant brightness.

**Z-Axis Input** — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 10 MHz.

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Altitude** — Operating: To 4500 m (15,000 ft); maximum allowable ambient temperature decreased by 1°C/1000 ft from 5000 ft to 15,000 ft. Nonoperating: 15 000 m (50,000 ft).

**Vibration** — Operating test samples were subjected to sinusoidal vibration in the X, Y, and Z axis with the frequency varied from 10 Hz to 55 Hz to 10 Hz in 1 minute sweeps for a duration of 15 minutes per axis and a dwell of 10 minutes at 55 Hz. Total displacement was 0.015 in p-p (2.4 g's at 55 Hz).

**Humidity** — Operating and Nonoperating: Test samples were subjected to 5 cycles (120 hours) of humidity testing.

**Shock** — Operating and Nonoperating: Test samples were subjected to 3 shocks, both directions along each axis for a total of 18 shocks. Peak accelerations of each ½-sine shock were 30 g's.

**EMC** — Radiated and Conducted Emission Requirements per VDE 0871: All 2200 Series instruments meet Class B.

### OTHER CHARACTERISTICS

**Probe Adjust Signal** — Squarewave, 0.5 V ±5%, 1 kHz ±20%.

**Power Requirements** — 90 V to 250 V, 48 Hz to 440 Hz without range switching, 40 W maximum.

### PHYSICAL CHARACTERISTICS

| Cabinet Dimensions | mm | in |
|---|---|---|
| Width (with handle) | 360 | 14.2 |
| Width (without handle) | 328 | 12.9 |
| Height (with feet and handle) | 137 | 5.4 |
| Depth (with front cover) | 445 | 17.5 |
| Depth (without front cover) | 440 | 17.3 |
| Depth (with handle extended) | 511 | 20.1 |
| **Weights ≈** | **kg** | **lb** |
| 2213A Net (with power cord) | 5.8 | 12.8 |
| 2215A Net (with power cord) | 6.1 | 13.5 |
| 2213A Shipping (domestic) | 7.8 | 17.3 |
| 2215A Shipping (domestic) | 8.2 | 18.0 |

### INCLUDED ACCESSORIES

Two P6122 10X voltage probes (010-6122-01); operator's manual.

## ORDERING INFORMATION

**2213A** Single Time Base Oscilloscope with Delayed Sweep ..... **$1,200**

**2215A** Delayed Alternate Time Base Oscilloscope ..... **$1,450**

Impact resistant packaging is available. Contact your local Tektronix Sales Engineer for details.

**Power Cords** — Standard: 110 V ac North American plug.

### INTERNATIONAL POWER CORDS & PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz. Order 020-0859-00.

**Option A2** — UK 240 V/13 A, 50 Hz. Order 020-0860-00.

**Option A3** — Australian 240 V/10 A, 50 Hz. Order 020-0861-00.

**Option A4** — North American 240 V/15 A, 60 Hz. Order 020-0862-00.

**Option A5** — Switzerland 220 V/10 A, 50 Hz. Order 020-0863-00.

***WARRANTY-PLUS* SERVICE PLANS—REFER TO PAGE 15**

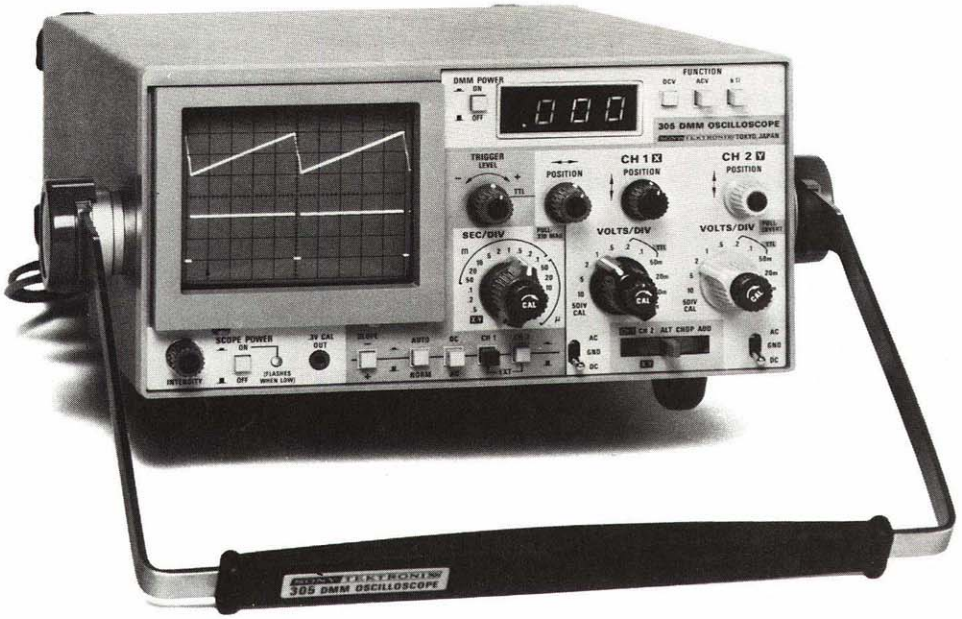
**M1 — (2213A) 2 Calibrations ..... +$85**
**M1 — (2215A) 2 Calibrations ..... +$100**
**M2 — (2213A) +2 Years Service ..... +$100**
**M2 — (2215A) +2 Years Service ..... +$110**
**M3 — (2213A) 2 Years Service & 4 Calibrations ..... +$265**
**M3 — (2215A) 2 Years Service & 4 Calibrations ..... +$290**
**M4 — (2213A) 5 Calibrations ..... +$270**
**M4 — (2215A) 5 Calibrations ..... +$295**
**M5 — (2213A) 9 Calibrations +2 Years Service ..... +$585**
**M5 — (2215A) 9 Calibrations +2 Years Service ..... +$620**

### OPTIONAL ACCESSORIES

**Front Panel Cover — Order (200-2520-00) ..... $5.00**
**Accessory Pouch — Order (016-0677-00) ..... $42**
**Pouch and Cover — Order (020-0672-02) ..... $47**
**Viewing Hood — Order (016-0566-00) ..... $15**
**Carrying Strap — Order (346-0199-00) ..... $15**
**Carrying Case — Order (016-0792-00) ..... $295**
**CRT Light Filter — Clear. Order (337-2775-00) ..... $3.00**
**C-5C Option 04 — Scope Camera ..... $495**
**K212 Portable Instrument Cart — For on-site portability. See page 429 for complete description. ..... $330**
**K117 Instrument Shuttle — For site-to-site portability. See page 429 for complete description. ..... $265**
**Rack Adaptor Kit — Order (016-0466-00) ..... $100**
**2213A Service Manual — Order (070-4733-00) ..... $25**
**2215A Service Manual — Order (070-4735-00) ..... $25**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

PORTABLE OSCILLOSCOPES




## 305

**5 MHz at 5 mV/div** — **Full X-Y**

**Dual Trace/DMM** — **Weighs ≈10.6 lb**

**Internal Battery Pack**

The 305 Oscilloscope/DMM is the ideal oscilloscope for those who demand portability and multifunction versatility in their test instrumentation.

The SONY®/TEKTRONIX® 305 combines a 5 MHz oscilloscope with an integral autoranging DMM and a built-in rechargeable battery pack. Take the 305 instead of multiple instruments when you climb the ladder to maintain your in-plant industrial controls. Or leave the extension cord at your bench when you go on location to service medical instrumentation.

The 305 features a dual-trace 5 MHz oscilloscope with a large 8 x 10 div (0.6 cm/div) CRT display and an autoranging DMM with dc and ac volts, and resistance measurement functions—all in a 10.6 lb (4.8 kg), 4.4 x 9.3 x 14.6 inch (11.2 x 23.6 x 37.1 cm) package. The front panel TTL marker presets the trigger generator for optimum level control on TTL signals.

## CHARACTERISTICS

### VERTICAL DEFLECTION

**Bandwidth** — Dc to at least 5 MHz. For ac coupling, the lower 3 dB point is ≈10 Hz.
**Deflection Factor** — 5 mV/div to 10 V/div (1-2-5 sequence) accurate ±3% from 0°C to +40°C, ±4% through remainder of operating range. Uncalibrated, continuously variable between steps and to at least 25 V/div.
**Display Modes** — CH 1, CH 2, Chopped, Alternate, Added, Invert CH 2 and X-Y. Bandwidth in Add mode is dc to at least 4.5 MHz.
**Input R & C** — 1 MΩ ±2%, paralleled by ≈47 pF.
**Maximum Input Voltage** — Ac or dc coupled, 250 V (dc + peak ac), or 250 V p-p at <1 kHz.

### HORIZONTAL DEFLECTION

**Time Base** — 500 ms/div to 1 μs/div (1-2-5 sequence). X10 magnifier extends sweep rate to 0.1 μs/div.
**Variable Time Control** — Uncalibrated, continuously variable between steps and to at least 1.25 s/div.

**Time Base Accuracy*[1]**

| | 0°C to +40°C | −15°C to +55°C |
|---|---|---|
| Unmagnified | ±3% | ±4% |
| Magnified | ±5% | ±6% |

*[1] Center 8 divisions (excludes first 10 divisions and all sweep past 90 divisions in X10 magnifier).*

### TRIGGER

**Modes** — Normal and Auto (p-p).
**TTL Triggering** — TTL position of trigger level control presets for optimum triggering from TTL levels, in 50 mV, 0.1 V and 0.2 V/div or external trigger signals.
**Trigger Sources** — Internal CH 1, internal CH 2, external. TTL Threshold voltage, internal (with 10X probe) 1.4 V within ±0.3 V, External (with 10X probe) 1.4 V within ±0.2 V.

**Trigger Sensitivity in Normal Mode**

| Coupling | To 0.5 MHz | At 5 MHz |
|---|---|---|
| Dc Internal | 0.3 div | 0.75 div |
| Dc External | 15 mV | 50 mV |
| Ac | Requirements increase below 60 Hz | |

**P-P Auto Operation Sensitivity**

| Coupling | 500 Hz to 0.5 MHz | 0.5 MHz to 5 MHz |
|---|---|---|
| Dc, Ac Internal | 0.5 div | 1.0 div |
| Dc, Ac External | 35 mV | 70 mV |

**External Trigger** — Maximum Input Voltage: 250 V (dc + peak ac) at 1 kHz or less (same as vertical). Input R and C: ≈1 MΩ paralleled by ≈47 pF.

### X-Y OPERATION

**Input** — X-axis input is via the CH 1 connector; Y-axis input is via the CH 2 connector.
**X-Y Characteristics** — Same as stated for vertical deflection, except deflection factor accuracy is ±4% from 0°C to +40°C over the center 8 div.
**X-Axis Bandwidth** — Dc to 150 kHz.

### DISPLAY

**CRT** — 8 x 10 div (0.632 cm/div) display. GH (P31) Phosphor is standard. 2 kV accelerating potential.
**Graticule** — Internal, nonilluminated.

## DMM

### DC VOLTAGE

**Ranges** — 2 V, 20 V, 200 V, 1000 V (autoranging).
**Accuracy** — Within 0.1% of reading, ±2 counts.
**Common-Mode Rejection** — >100 dB at dc, 80 dB at 60 Hz with 1 kΩ imbalance.
**Normal-Mode Rejection** — >30 dB at 60 Hz increasing 20 dB per decade to 2 kHz.
**Response** — <1 s plus range step time (<1 s/step).
**Input R** — 10 MΩ ±2%.
**Maximum Input Voltage** — ±1000 V (dc + peak ac) between HI and LO inputs or between HI and chassis. ±500 (dc + peak ac) between LO and chassis (LO Floating Voltage).

### AC VOLTAGE

**Ranges** — 2 V, 20 V, 200 V, 700 V, (autoranging).
**Accuracy** — Within 0.5% of reading, ±10 counts, 40 Hz to 500 Hz.
**Response Time** — <5 s plus range step time (<1 s/step).
**Input Impedance** — 10 MΩ paralled by ≈70 pF.
**Maximum Input Voltage** — 700 V RMS if sinusoidal. ±1000 V (dc + peak ac) between HI and LO inputs or between HI and chassis. ±500 V (dc component) between HI and LO inputs.
±500 V (dc + peak ac) between LO and chassis (LO Floating Voltage).

### RESISTANCE

**Ranges** — 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ.
**Accuracy** — Within 0.6% of reading ±3 counts.
**Response Time** — <5 s plus range step time (<1 s/step).
**Maximum Input Voltage** — ±100 V (dc + peak ac) between HI and LO inputs. 500 V (dc + peak ac) between LO and chassis (LO Floating Voltage).

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Operating: −15°C to +55°C (Oscilloscope), 0°C to +55°C (DMM). Nonoperating: −25°C to +75°C.
**Altitude** — Operating: To 9000 m (30,000 ft) maximum, decrease maximum temperature by 1°C/1000 ft from 5,000 ft to 30,000 ft. Nonoperating: To 15 000 m (50,000 ft) maximum.
**Vibration** — 15 minutes along each of the 3 major axes, 0.025 in (0.06 cm) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles.
**Humidity** — Nonoperating: 5 cycles (120 hours) of MIL-E-16400G. Omit freezing and vibration and allow a post-test drying period at +25°C, ±5°C and 20% to 80% relative humidity.
**Shock** — Operating and Nonoperating: 30 g's, ½ sine, 11 ms duration. Total of 12 shocks.

### OTHER CHARACTERISTICS

**Amplitude Calibrator** — 0.3 V accurate ±1% from 20°C to 30°C ±2% from −15°C to +55°C.
**Power Sources** — External ac source, 90 V to 132 V or 180 V to 250 V with a line frequency of 48 Hz to 440 Hz. Maximum power dissipation of 17 W. External dc source +9 V to +32 V.
**Charge Time** — At least 16 hours for full charge.
**Operating Time** — Internal NiCd batteries provide ≈1.6 hours of scope and DMM operation, 10 hours of DMM alone operation, or two hours of scope alone operation at maximum trace intensity and 20°C to 25°C operating temperature.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width (with handle) | 236 | 9.3 |
| Height | 112 | 4.4 |
| Depth (handle not extended) | 371 | 14.6 |
| Depth (handled extended) | 458 | 18.0 |
| **Weights ≈** | **kg** | **lb** |
| Net (without accessories) | 4.8 | 10.6 |
| Shipping | 7.8 | 17.1 |

### INCLUDED ACCESSORIES

Two P6149 10X probes (010-6149-03); carrying case (016-0401-00); carrying case cover (200-2260-00); carrying strap assembly (346-0131-02); DMM probe package (012-0732-00); clear CRT filter (331-0394-01); blue CRT filter (378-2016-01); external dc cable assembly (012-0406-00); service manual; operator's manual.

## ORDERING INFORMATION

**305** DMM/Oscilloscope ..... **$2,405**
The SONY®/TEKTRONIX® 305 DMM/Oscilloscope is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 305 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

### OPTIONAL ACCESSORIES

**Viewing Hood** — Order 016-0297-00 ..... **$2.00**
**Adaptor Connector** — BNC to binding post. Order 103-0033-00 ..... **$5.00**
**K212 Portable Instrument Cart** — For on-site portability. ..... **$330**
**K117 Instrument Shuttle** — For site-to-site portability. ..... **$265**
**See page 429 for complete description on carts.**

### RECOMMENDED CAMERA

**C-30BP Option 01** — General purpose camera. Order C-30BP Option 01 ..... **$1,489**
**Camera Adaptor** — Required to mount the C-30BP Camera to the 305. Order 016-0327-01 ..... **$170**
**For further information see camera section.**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

# 221

**5 MHz, 5 mV/div to 100 V/div**

**0.1 μs/div Sweep Rate with X10 Sweep Magnifier**

**Internal Battery Pack**

**Integral 1 MΩ Probe**

**Weighs ≈1.6 kg (3.5 lb)**

The 221 Miniscope weighs just 3.5 pounds and measures only 3 x 5.2 x 9 inches. It easily fits into a tool box or brief case, yet has the capability needed for on-site service of much of today's complex equipment. This versatile miniscope has a 5 MHz bandwidth, 5 mV/div sensitivity, and 0.1 μs/div sweep rate (using X10 magnifier) packaged in an impact-resistant case.

Internal rechargeable batteries allow at least two hours operation away from external power sources. And the 221 will operate and charge from practically all the world's principal line voltages: 90 V to 250 V, 48 Hz to 62 Hz ac, or 80 V to 250 V dc (all without making any change to the instrument).

The 1 MΩ low-capacitance probe minimizes circuit loading. And because it's attached, it's always there when you need it. Vertical deflection factors extend from 5 mV/div, allowing on-screen measurement of signals up to 600 V dc + peak ac. The 1 μs/div to 200 ms/div time base is enhanced by a X10 magnifier that extends the fastest range to 0.1 μs/div. A variable control will slow the sweep to about 0.5 s/div.

A single rotary control on the 221 is used for all trigger level and slope functions. Controls are side mounted and recessed for protection, yet are easily accessible.

In applications where it is necessary to "float" the oscilloscope to make your measurements, 200 Series miniscopes can be elevated to 700 V (dc + peak ac) above ground when operated from batteries. Although insulated, caution should be observed when connecting the probe to test points.

The 221 is used in a wide assortment of service applications. For example, in data transmission systems, the 221 is preferred for maintenance and testing of modems because of its ability to see higher frequency noise. It can even help in building roads by spot checking motors in a road grader's closed loop servo system that controls blade angle, depth of cut and machine direction.

## CHARACTERISTICS

### VERTICAL DEFLECTION

**Bandwidth** — Dc to 5 MHz (−3 dB point) at all calibrated deflection factors. Lower −3 dB point ac coupled is ≈2 Hz.

**Deflection Factor** — 5 mV/div to 100 V/div, accurate ±3% from 0°C to +40°C and ±5% from −15°C to 0°C and +40°C to +55°C. Uncalibrated, continuously variable between steps to at least 300 V/div.

**Input R and C** — ≈1 MΩ paralleled by ≈29 pF via attached signal acquisition probe.

**Maximum Input Voltage** — 600 V (dc + peak ac), 600 V p-p ac, 5 MHz or less.

### HORIZONTAL DEFLECTION

**Time Base** — 1 μs/div to 200 ms/div, accurate ±3%.

**Magnifier** — Increases all sweep speeds X10 with a maximum sweep speed of 0.1 μs/div.

**Variable Time Control** — Extends minimum sweep rate to ≈0.5 s/div. Continuously variable between calibrated settings.

### TRIGGER

**Modes** — Automatic or manual. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

**Trigger Sensitivity**

| Source | To 1 MHz | At 5 MHz |
|---|---|---|
| Internal | 0.5 div | 1 div |
| External | 0.5 V | 1 V |

### X-Y OPERATION

**Input** — X-axis input is via the external trigger or the external horizontal input.

**X-Axis Deflection Factor** — 1 V/div ±10%, dc to 500 kHz. Sensitivity is increased by a factor of 10 (0.1 V/div) using horizontal magnifier.

**Maximum External Horizontal Input Voltage** — 200 (dc + peak ac), 200 V (p-p ac) to 500 kHz, decreasing to 20 V p-p ac at 5 MHz.

**Input Impedance** — ≈0.5 MΩ paralleled by ≈30 pF.

### DISPLAY

**CRT** — 6 x 10 div (0.52 cm/div) display. GH (P31) Phosphor normally supplied. 1 kV accelerating potential.

**Graticule** — Internal, black line, nonilluminated.

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Operating (Battery Only): −15°C to +55°C. Charging or Operating from Ac Line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

**Altitude** — Operating: 7600 m (25,000 ft), decrease maximum temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 15 000 m (50,000 ft).

**Vibration** — Operating and Nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

**Humidity** — 5 days at +50°C, 95% humidity.

**Shock** — Operating and Nonoperating: 100 g's, ½ sine, 2 ms duration each direction along each major axis. Total of 12 shocks.

### OTHER CHARACTERISTICS

**Power Sources** — Internal NiCd batteries provide at least 2 hours operation at maximum trace intensity for a charging and operating temperature between +20°C and +30°C. Internal charger charges the batteries when connected to an ac line with instrument turned on or off. Dc operation is automatically interrupted when battery voltage drops to ≈10 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. Extended time charges will not damage the batteries. An expanded scale battery meter indicates full, low, and recharge. External power source, 90 V to 250 V ac (48 Hz to 62 Hz) or 80 V to 250 V dc, 5 W or less.

**Insulation Voltage** — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries, with the line cord stored and the plug protected. When operated from an external line, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4 times line + (dc + peak ac) not to exceed 350 V.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 133 | 5.2 |
| Height | 76 | 3.0 |
| Depth | 228 | 9.0 |
| **Weights ≈** | **kg** | **lb** |
| Net (w/o accesssories) | 1.6 | 3.5 |
| Shipping | 3.6 | 8.0 |

### INCLUDED ACCESSORIES

Viewing hood (016-0199-01); carrying case (016-0512-00); neck strap (346-0104-00); two spare fuses (159-0080-00); service manual; operator's manual.

## ORDERING INFORMATION

**221** Oscilloscope, Includes Batteries and Probes ..... **$2,100**

### OPTIONAL ACCESSORIES

**Alligator Clip Kit** — A pair of alligator clips that allow connecting the probe and ground lead to large (up to ⅜ inch) conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adaptor (103-0051-01). Order 015-0231-00 ..... **$21**

**Probe-Tip** — To BNC Panel Connector Adaptor. Order 013-0084-01 ..... **$8.00**

**Probe-Tip** — To BNC Cable Adaptor. Order 103-0096-00 ..... **$11.00**

**Power Cable Adaptor Assembly** — A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied. Order 161-0077-01 ..... **$9.00**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## 213

**1 MHz at 20 mV/div**

**0.4 µs/div Sweep Rate with X10 Sweep Magnifier**

**DMM and Miniscope in One Unit**

**Rugged Construction**

**Internal Battery**

**Compact, Weighs ≈1.7 kg (3.7 lb)**

**True RMS Voltage & Current Measurements**

The 213 combines a precision 3½ digit digital multimeter and a 1 MHz oscilloscope in one instrument. It is a compact (3 x 5.2 x 8.9 inches) and light weight (only 3.7 pounds) package that will fit easily into your briefcase or tool kit.

In operation, the light weight 213 can be hand held, rested on the equipment being tested or carried conveniently on a neck-strap. Operating controls are designed for speedy measurements and easy understanding.

Rugged construction enables the 213 to withstand hostile industrial or transportation environments.

The 213, combining both oscilloscope and DMM functions, fits many on-site service applications. As an example, the 213 is used extensively for preventive maintenance on industrial control systems.

## CHARACTERISTICS

### VERTICAL DEFLECTION (VOLTAGE)

**Bandwidth** — Dc to 1 MHz (−3 dB point) for 20 mV/div to 100 V/div deflection factors. Dc to 400 kHz (−3 dB point) for 5 mV/div and 10 mV/div. Lower −3 dB point for ac coupling is ≈1 Hz.
**Deflection Factor** — 5 mV/div to 100 V/div (1-2-5 sequence). Accuracy: ±3%. Uncalibrated: Continuously variable between steps to at least 250 V/div.
**Input R and C** — 10 MΩ paralleled by 150 pF for 5 mV/div through 1 V/div and 100 pF for 2 V/div through 100 V/div.
**Maximum Input Voltage**

| Input Condition | Maximum Input Voltage |
|---|---|
| Dc coupled, 5 mV/div to 1 V/div | 500 V (dc + peak ac) at 1 MHz or less |
| Ac coupled, 5 mV/div to 1 V/div | 800 V (dc + peak ac) 500 V peak ac component |
| Ac, Dc coupled, 2 V/div to 100 V/div | 800 V (dc + peak ac) at 1 MHz or less |

### VERTICAL DEFLECTION (CURRENT)

**Bandwidth** — Dc to at least 400 kHz (−3 dB point) for 20 µA/div through 100 mA/div deflection factors. Dc to at least 200 kHz (−3 dB point) for 5 µA/div and 10 µA/div.
**Deflection Factor** — 5 µA/div to 100 mA/div (1-2-5 sequence). Accuracy: ±3%. Uncalibrated: Continuously variable between steps to at least 250 mA/div.
**Maximum Input Current** — 2 A RMS or 3 A peak for any range (fuse and diode protection).

### HORIZONTAL DEFLECTION

**Time Base** — 2 µs/div to 500 ms/div (1-2-5 sequence). Accuracy: ±5%.
**Variable Magnifier** — Increases all sweep speeds to at least X5 with a maximum sweep speed of 0.4 µs/div.

### TRIGGER

**Modes** — Normal (sweep runs when triggered). Automatic (sweep free-runs in absence of trigger signal or for frequencies below 7 Hz).
**Trigger Sensitivity and Coupling** — Ac Internal: (Auto and Normal 1 MHz) 0.5 div. Dc External: 1 MHz, 1 V.

### DISPLAY

**CRT** — 6 x 10 div (0.52 cm/div) display. GY (P43) Phosphor.
**Graticule** — Internal, black line, nonilluminated.

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Operating (Battery Only): −15°C to +55°C. Charging or Operating from Ac Line: 0°C to +40°C. Nonoperating: −40°C to +60°C.
**Altitude** — Operating: To 7500 m (25,000 ft), decrease maximum temperature by 1°C/1,000 ft above 15,000 ft. Nonoperating: 12 500 m (40,000 ft).
**Vibration** — Operating and Nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.
**Humidity** — +40°C or less, 80% or less relative humidity.
**Shock** — Operating and Nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

### OTHER CHARACTERISTICS

**Power Sources** — Internal NiCd batteries provide three to five hours operation at maximum trace intensity for a charging and operating temperature between +20°C and +30°C. Internal charger charges batteries when connected to an ac line with instrument turned on or off. Dc operation is automatically interrupted when battery voltage drops below 2 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. External power source, 90 V to 136 V ac (48 Hz to 62 Hz). Option 01 allows operation from an external 180 V to 250 V ac (48 Hz to 62 Hz) or dc supply. Power consumption, 8 W or less.
**Insulation Voltage** — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries with line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V RMS or 1.4X line + (dc + peak ac) not to exceed 350 V.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 133 | 5.2 |
| Height | 76 | 3.0 |
| Depth | 226 | 8.9 |
| **Weights ≈** | **kg** | **lb** |
| Net (without accessories) | 1.7 | 3.7 |
| Shipping | 3.9 | 8.6 |

### DMM

Provides true RMS readings of voltage and current.

### DC AND AC VOLTAGE

**Range** — 0.1 V to 1000 V full scale in five ranges.
**Resolution** — 100 µV at 0.1 V full scale.
**Accuracy in Dc Mode** — For +25°C ±5°C.

| Range*1 | |
|---|---|
| 0.1 V | ±0.1% of reading ±3 counts. Temp coef is (±0.015% of reading +0.04% of full scale) per °C |
| 1 V | ±0.1% of reading ±1 count. Temp coef is (±0.01% of reading +0.01% of full scale) per °C |
| 10 V and 100 V | ±0.15% of reading ±1 count. Temp coef is (±0.015% of reading +0.01% of full scale) per °C |
| 1000 V | ±0.2% of reading ±1 count. Temp coef is (±0.02% of reading +0.01% of full scale) per °C |

*1 *Full scale*
**Accuracy in RMS Mode** — For 25°C ±5°. Temperature coefficient (±0.05% of reading +0.1% of full scale) per °C.

| Range | Within % of reading shown ±5 counts*1 | | |
|---|---|---|---|
| | Dc | 40 Hz to 4 kHz | 4 kHz to 40 kHz |
| 0.1 V | 2.5% | 1.5% | 3.5% |
| 1 V, 10 V, & 100 V | 2% | 1% | 1% |
| 1000 V | 2% | 1% | 2% |

*1 *Accuracy limit increases linearly for crest factor >2 up to twice indicated limit for crest factor of five.*
**Input Resistance** — 10 MΩ.
**Input Capacitance** — 150 pF on 0.1 V to 10 V ranges, 100 pF on 100 V and 1000 V ranges.
**Settling Time** — Dc: 1.5 s to 0.1% of reading. RMS: 2 s to 1% of reading.
**Maximum Input Voltage**

| Range | Dc Coupled | Ac Coupled |
|---|---|---|
| 0.1 V to 10 V | 500 V*1 | 800 V*1 |
| 100 V to 1000 V | 800 V*1 | |

*1 *Dc + peak ac*

### DC AND AC CURRENT

**Range** — 0.1 mA to 1000 mA full scale in five ranges.
**Resolution** — 100 nA at 0.1 mA full scale.
**Accuracy in Dc Mode** — For +25°C ±5°C.
**Temperature Coef** — (±0.02% of reading ±0.04% of full scale) per °C. 0.1 mA ±0.5% ±3 counts. 1 mA to 1000 mA ±0.25% ±3 counts.
**Accuracy in Ac Mode**

| Range | Within % of reading shown ±5 counts*1 | | |
|---|---|---|---|
| | Dc | 40 Hz to 4 kHz | 4 kHz to 40 kHz |
| 0.1 mA | 2.5% | 1.5% | 4.5% |
| 1 mA to 1000 mA | 2.5% | 1.5% | 3.5% |

*1 *Accuracy limit increases linearly for crest factor >2 up to twice the indicated limit for crest factor of five.*
**Settling Time** — 1.5 s to 0.1% of reading.
**Maximum Input Current** — 2 A RMS or 3 A peak on any scale (fuse and diode protection).

### RESISTANCE

**Ranges** — 1 kΩ to 10 MΩ full scale in five ranges.
**Resolution** — 1 Ω on 1 kΩ scale.
**Accuracy** — For 25°C ±5°C.

| Range | % of Reading |
|---|---|
| 1 kΩ | 0.5% ±3 counts |
| 10 kΩ to 1 MΩ | 0.5% ±1 count |
| 10 MΩ | 1% ±1 count |

**Settling Time** — Two seconds ±2 counts.

### READOUT

**Number of Digits** — 3½ digits plus decimal point and sign.
**Display Size** — 1 cm high by 4 cm wide (five characters).
**Over-Range Capability** — At least 200% of full scale.
**Over-Range Indication** — Displays scrambled characters.

### INCLUDED ACCESSORIES

Viewing hood (016-0199-01); carrying case (016-0512-00); two alligator clip to banana jack test leads (red 012-0015-00, black 012-0014-00); neck strap (346-0104-00); two power line fuses (159-0080-00); identification tag (334-2614-00); identification tag (000-7983-00); Option 01 power line plug adaptor (161-0077-01); service manual; operator's manual.

## ORDERING INFORMATION

**213** Miniscope/DMM (Includes Batteries and Probe) ..... **$2,625**
**Option 01** — 180 V to 250 V ac (48 Hz to 62 Hz) or dc (includes batteries and probe) ..... **NC**

### OPTIONAL ACCESSORIES

**Alligator Clip Kit** — A pair of alligator clips that allow connecting the probe and ground lead to large (up to ⅜ in) conductor. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adaptor (103-0051-01). Order 015-0231-00 ..... **$21**
**Probe-Tip** — To BNC Panel Connector Adaptor. Order 013-0084-01 ..... **$8.00**
**Probe Tip** — To BNC Cable Adaptor. Order 103-0096-00 ..... **$11.00**
**Power Cable Adaptor Assembly** — A 11 inch two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied. Order 161-0077-01 ..... **$9.00**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## 212

**500 kHz, 1 mV/div to 50 V/div**

**Internal Battery**

**Integral 1 MΩ Probe**

**Weighs ≈1.6 kg (3.5 lb)**

The 212 features these signal acquisition capabilities: bandwidth to 500 kHz with deflection factors from 1 mV/div to 50 V/div. It is light weight (only 3.5 pounds) and compact (3 x 5.25 x 9.5 inches).

Built of impact-resistant plastic and fully self-contained, this miniature portable is perfect for applications in severe environments. And it permits "floating" measurements since it is double insulated and can be elevated to 700 V (dc + peak ac) above ground when operated from batteries. Although insulated, normal caution should be observed when connecting the oscilloscope probe to the test point.

The 212 features integral probes that are color matched with the vertical deflection controls to minimize measurement error. The probes have their own storage space and are part of the instrument—you can't forget and leave them behind. Clip-on 10X attenuators are available for higher voltage applications.

Trigger level and slope functions are simplified to one rotary control on the side of the unit. A convenient neckstrap is an included accessory, freeing both hands to perform other tasks.

## CHARACTERISTICS

### VERTICAL DEFLECTION

**Bandwidth** — Dc to at least 500 kHz from 10 mV/div to 50 V/div, reducing to at least 100 kHz at 1 mV/div. Lower −3 dB point ac coupled is ≈2 Hz.

**Deflection Factors** — 1 mV/div to 50 V/div (1-2-5 sequence). Accuracy: ±5%. Uncalibrated: Continuously variable between steps to at least 125 V/div.

**Display Modes** — CH 1 only, CH 2 only, or CH 1 and CH 2 Chopped (chop rate ≈50 kHz) from 500 ms/div to 2 ms/div of time base, alternate from 1 ms/div to 5 μs/div of time base.

**Input R and C** — ≈1 MΩ paralleled by ≈160 pF from 1 mV/div to 50 mV/div; and 140 pF from 100 mV/div to 50 V/div.

**Maximum Input Voltage*1**

| | |
|---|---|
| 1 mV/div to 50 mV/div | 600 V (dc + peak ac) ac not over 2 kHz. |
| 0.1 V/div to 50 V/div | 600 V (dc + peak ac) 600 V p-p ac 5 MHz or less |

*1 1X probe only*

### HORIZONTAL DEFLECTION

**Time Base** — 5 μs/div to 500 ms/div, accurate ±5%.

**Variable Magnifier** — Increases each sweep rate X5 with a maximum sweep speed of 1 μs/div.

**External Horizontal Input** — (CH 1) 1 mV/div to 50 V/div ±10%; dc to 100 kHz: X-Y phasing to 5 kHz <3°. Input characteristics same as CH 1.

**Maximum External Horizontal Input Voltage and Impedance** — Same as for vertical inputs.

### TRIGGER

**Modes** — Automatic or normal. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

**Trigger Sensitivity and Coupling**

| Dc Coupling | To 500 Hz |
|---|---|
| Internal (w/composite trigger source) | 0.2 div |
| Internal (w/CH 2 trigger source) | 0.2 div |
| External | 1 V |

**Maximum External Trigger Input Voltage** — 8 V (dc + peak ac), 16 V (p-p ac) at 500 kHz or less.

**Input Impedance** — R and C, 1 MΩ paralleled by ≈30 pF.

### DISPLAY

**CRT** — 6 x 10 div (0.52 cm/div) display. GH (P31) Phosphor is standard.

**Graticule** — Internal, black line, nonilluminated.

### ENVIRONMENTAL CAPABILITIES

**Ambient Temperature** — Operating (Battery Only): −15°C to +55°C. Charging or Operating from Ac Line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

**Altitude** — Operating: 7500 m (25,000 ft), decrease maximum temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 15 000 m (50,000 ft).

**Vibration** — Operating and Nonoperating: 15 minutes along each of the three major axes. 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

**Humidity** — Five cycles (120 hours). 95% Relative Humidity, referenced to MIL-E-16400F.

**Shock** — Operating and Nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

### OTHER CHARACTERISTICS

**Power Sources** — Internal NiCd batteries provide ≈ three to five hours operation for a charging and operating temperature between +20°C and +30°C. Internal charger charges the batteries when connected to an ac line with instrument turned off. Battery operation is automatically interrupted when battery voltage drops to ≈10 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. Extended charge times will not damage the batteries.

A pilot light battery-charge indicator light will extinguish when oscilloscope has about ten minutes of operating time remaining in the batteries.

**External Ac Source** — 110 V to 126 V, 58 Hz to 62 Hz, 3 W. Can be operated at 104 V to 110 V with resulting slow discharge of internal batteries.

**Insulation Voltage** — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries, with the line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4X line + (dc + peak ac) not to exceed 350 V.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 133 | 5.3 |
| Height | 76 | 3.0 |
| Depth | 241 | 9.5 |
| **Weights ≈** | **kg** | **lb** |
| Net (without accessories) | 1.6 | 3.5 |
| Shipping | 3.2 | 7.0 |

### INCLUDED ACCESSORIES

Viewing hood (016-0199-01); carrying case (016-0512-00); two 4-A fuses (159-0121-00); identification tags (000-7983-00); identification tag (334-2614-00); carrying strap (346-0104-00); service; operator's manual.

## ORDERING INFORMATION

**212** Dual-Trace Oscilloscope (Includes Batteries and Probes) ..... **$1,895**

### POWER OPTIONS

**Option 01** — For 220 V to 250 V (48 Hz to 52 Hz). Includes Batteries ..... **NC**

**Option 02** — For 90 V to 110 V (48 Hz to 52 Hz). Includes Batteries ..... **NC**

### OPTIONAL ACCESSORIES

**10X Attenuator Package** — A slip-on tip to provide lower circuit loading (4.4 MΩ, ≈20 pF) and higher maximum input voltage 1000 V (dc + peak ac) includes: 10X attenuator (010-0378-01); pincher tip (013-0071-00); flex tip (206-0060-00); banana tip (134-0013-00); IC adaptor (206-0203-00). Order 010-0378-01 ..... **$60**

**Alligator Clip Kit** — A pair of alligator clips that allow connecting the probe (or optional 10X attenuator) and ground lead to large ⅜ in) conductors. Includes: 6-32 to probe adaptor (103-0051-01); red clip (015-0229-00); yellow clip (015-0230-00). Order 015-0231-00 ..... **$21**

**Probe-Tip** — To BNC Panel Connector Adaptor. Order 013-0084-01 ..... **$8.00**

**Probe-Tip** — To BNC Cable Adaptor. Order 103-0096-00 ..... **$11.00**

**Power Cable Adaptor Assembly** — A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied. Order 161-0077-01 ..... **$9.00**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

# PORTABLE STORAGE OSCILLOSCOPES

## GPIB IEEE-488 468/R468

The 468 and R468 with Option 02 comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**10 MHz Useful Storage Bandwidth**

**Cursors for Time and Voltage Measurements**

**Signal Averaging**

**Envelope Mode (Patented)**

**GPIB Option**

**100 MHz Nonstorage Bandwidth**

Advancing the state-of-the-art in digital storage oscilloscopes is the Tektronix 468. This high performance portable scope is capable of accurately storing and displaying 10 MHz single shot events using a unique display interpolation system.

The 468 was designed with many features which enhance its usefulness in your applications. Cursors and a calibrated LED readout enable you to measure time or voltage differences easily and accurately.

Signal Averaging, now standard on the 468, can be used to remove random noise from a signal and improve measurement accuracy.

Option 02 provides a GPIB interface (talk only). This transmits stored waveforms and scale factor information to a listener or controller.

For floating measurements, order A6902A Isolator. See page 434 for complete description.

**See page 330 for complete description and specifications of the 468.**

## GPIB IEEE-488 336

The 336 with Option 01 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**1 MS/s, 140 kHz Useful Storage Bandwidth**

**Cursors for Time and Voltage Measurements**

**Signal Averaging**

**Envelope Mode**

**GPIB and 8 Screen Memory Option (16 k)**

**50 MHz Nonstorage Bandwidth**

**CRT Readout**

The SONY/TEKTRONIX 336 is a combination nonstorage and digital storage portable oscilloscope. It is capable of displaying analog and digitized waveforms simultaneously, and can store up to 18 digitized waveforms for recall and display. The 336 is a microprocessor controlled instrument that incorporates alphanumeric CRT readouts of the vertical and horizontal scale factors, the delay time position, and voltage and time readouts of the cursor positions. Many of the oscilloscope features and modes are chosen from a menu displayed on the CRT rather than from hard-wired front-panel switches. Also included is an Auto mode for both vertical volts per division and horizontal time per division, allowing "hands off" operation in many applications.

Option 01 provides the additional signal transmission capability of a GPIB talker only interface and added storage space for up to 18 waveforms total storage capability in View memory. A backup battery with Option 01 maintains the stored waveform data and front panel settings while the instrument is off for periods of at least three days (after the battery is charged during operation of the 336).

**See page 332 for complete description and specifications of the 336.**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## 466/464

**100 MHz at 5 mV/div**

**5 ns/div Sweep Rate with X10 Sweep Magnifier**

**Variable Persistence and Fast Mesh Transfer Storage Modes**

**3000 div/μs Stored Writing Speed (466)**

**Battery Operation (Optional)**

**Third Channel Trigger View**

**Weighs ≈11.8 kg (26 lb)**

The 466 and 464 Portable Storage Oscilloscopes are both designed to display nonrepetitive or slow moving signals. And with the exception of increased stored writing speed on the 466, both instruments offer similar performance.

Operating in a reduced scan mode, the stored writing speed of the 466 is 3000 div/μs (1350 cm/μs). The lower cost 464 doesn't offer a reduced scan mode and stores at 110 div/μs. Both instruments feature two modes of storage — variable persistence and fast transfer.

The bright 8 x 10 div CRT on both instruments comprises 0.90 cm/divisions. In the 466, reduced scan graticule is superimposed over the center of the main graticule, measuring 8 x 10 divisions with 0.45 cm/division. All graticules are etched onto the inner face of the CRT to eliminate parallax problems. A third channel trigger view is included for the 466 and 464. This allows the simultaneous display of channels 1 and 2 with the external A trigger.

Tektronix P6062B Probes provide operator convenience of 1X or 10X input attenuation at the probe tip. The correct deflection factor is automatically indicated on the 464 or 466 front panel when the probe attenuation factor is switched.

Light weight plus the ability to use optional, external dc power makes both the 466 and 464 sufficiently portable for virtually all field measurement applications. The snap-on 1106 Battery Pack is also useful in isolating these oscilloscopes from noisy or intermittent power sources.

### CHARACTERISTICS

All characteristics apply to both the 466 and 464, except where indicated.

#### VERTICAL DEFLECTION (2 IDENTICAL CHANNELS)

**Bandwidth*1 and Risetime** — At all deflection factors from 50 Ω terminated source.

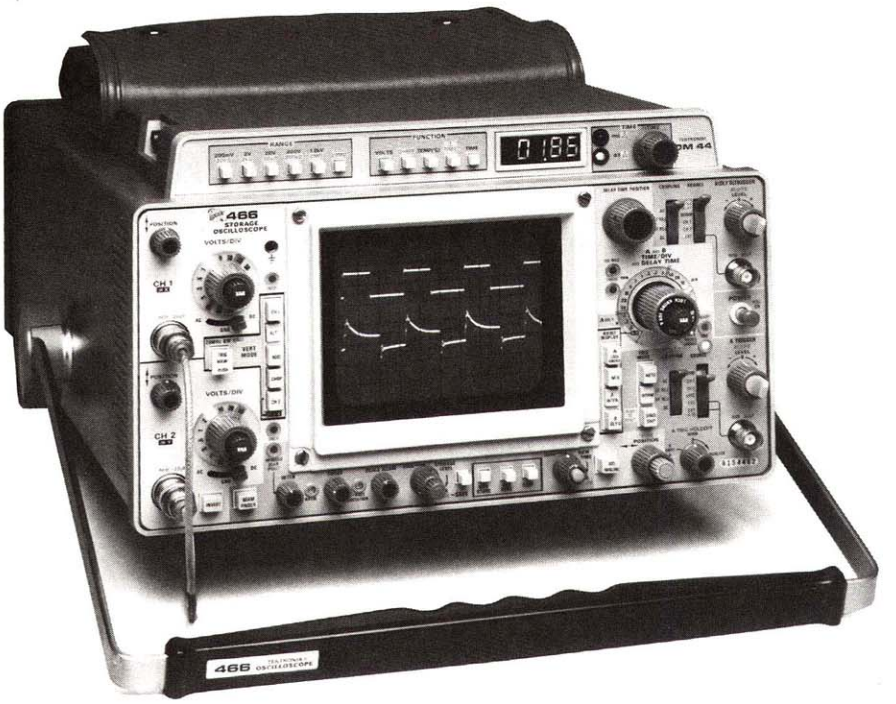
| −15°C to +40°C | +40°C to +55°C |
|---|---|
| Dc to 100 MHz, ≤3.5 ns | Dc to 85 MHz, ≤4.15 ns |

*1 *Measured at −3 dB down. Bandwidth may be limited to ≈20 MHz by bandwidth limit switch. Lower −3 dB point, ac coupling 1X probe; 10 Hz or less. 10X probe; 1 Hz or less.*

**Deflection Factor** — 5 mV/div to 5 V/div (1-2-5 sequence). Accuracy: ±3%. Uncalibrated: Continuously variable between steps and to ≈12.5 V/div. In cascade mode sensitivity is ≈1 mV/div. Cascaded bandwith is at least 50 MHz when signal out is terminated in 50 Ω.

**Display Modes** — CH 1, CH 2 (normal or inverted), alternate, chopped (≈250 kHz), added, X-Y.

**Common-Mode Rejection Ratio** — At least 20 dB at 20 MHz for common-mode signals of 6 div or less.



*466 DMM with Differential Time DMM Option*

**Automatic Scale Factor** — Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two readout lights behind the knob skirts. All lights are off when the channel is not displayed. Ground reference display selectable at probe (when dc coupled).

**Input R and C** — 1 MΩ ±2% paralled by ≈20 pF.

**Maximum Input Voltage**

| | |
|---|---|
| Dc Coupled | 250 V (dc + peak ac)<br>500 V (p-p ac at 1 kHz or less) |
| Ac Coupled | 500 V (dc + peak ac)<br>500 V (p-p ac at 1 kHz or less) |

**Delay Line** — Permits viewing leading edge of displayed waveform.

#### HORIZONTAL DEFLECTION

**Time Base A** — 0.05 μs/div to 0.5 s/div (1-2-5 sequence). X10 magnifier extends sweep rate to 5 ns/div.

**Time Base B** — 0.05 μs/div to 50 ms/div (1-2-5 sequence). X10 mag extends sweep rate to 5 ns/div.

**Variable Time Control** — Time Base A: Provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

**Time Base A and B Accuracy.*1**

| | +20°C to +30°C | −15°C to +55°C |
|---|---|---|
| Unmagnified | ±2% | ±3% |
| Magnified | ±3% | ±4% |

*1 *Full 10 divisions.*

**Horizontal Display Modes** — A, mixed sweep, A intensified, B delayed. B ends A for increased intensity in the delayed mode.

**Calibrated Mixed Sweep** — Displays A sweep for period determined by Delay-Time Position control, then displays B sweep for remainder of horizontal sweep.

#### CALIBRATED SWEEP DELAY

**Delay Time Range** — 0.2 to X10 delay time/div settings of 200 ns to 0.5 s (minimum delay time is 200 ns).

**Differential Time Measurement Accuracy**

| Delay Time Setting | +15°C to +35°C | −15°C to +55°C |
|---|---|---|
| Over one or more major dial div | ±1% | ±2.5% |
| Less than one major dial div | ±0.01 major dial div | ±0.025 major dial div |

**Jitter** — One part or less in 50,000 (0.002%) of X10 the A sweep time/div setting.

#### TRIGGER

**A Trigger Modes** — Normal (sweep runs when triggered), automatic (sweep free-runs in the absence of a triggering signal and for signals below 30 Hz). Single Sweep (sweep runs one time on the first triggering event after the reset selector is pressed). Lights indicate when sweep is triggered and when single sweep is ready.

**A Trigger Holdoff** — Adjustable control permits a stable presentation of repetitive complex waveforms. At least 10:1 variation.

**B Trigger Modes** — B starts after delay time (starts automatically at the end of the delay time). B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

**Time Base A and B Trigger Sensitivity and Coupling**

| Coupling | To 25 MHz | At 100 MHz |
|---|---|---|
| Dc Internal | 0.3 div deflection | 1.5 div deflection |
| Dc External | 50 mV | 150 mV |
| Dc External ÷ 10 | 500 mV | 1.5 V |
| Ac | Requirements increase below 60 Hz | |
| Ac LF Reject | Requirements increase below 50 kHz | |
| Ac HF Reject | Requirements increase below 30 Hz and above 50 kHz | |

**Jitter** — 0.5 ns or less at 100 MHz and 5 ns/div (X10 magnifier).

**A Trigger View** — A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal. The deflection factor is ≈50 mV/div (0.5 V/div with external ÷10 source).

**Level and Slope** — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. Level adjustment through at least ±2 V in external, through at least ±20 V in external ÷10.

**A Sources** — Normal, CH 1, CH 2 line, external and external ÷ 10.

**B Sources** — Starts after delay, normal, CH 1, CH 2, and external.

**External Inputs** — R and C ≈1 MΩ paralleled by ≈20 pF. 250 V (dc + peak ac) maximum input.

**Third Channel Trigger View** — Deflection Factor (Dc Trigger Coupling Only). Ext is: 100 mV/div ±5%. Ext ÷ 10 is: 1 V/div ±5%. Delay Difference: 5.0 ns ±0.5 ns after vertical display. Trigger Point: ≈ center screen. Risetime: ≤5 ns. Aberration: <10% p-p.

### X-Y OPERATION

**Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical)** — 5 mV/div to 5 V/div. Accuracy: ±4%. Bandwidth: Dc to at least 4 MHz. Phase Difference Between Amplifiers: 3° or less from dc to 50 kHz.

### DISPLAY

**CRT** — 8 x 10 div display, each div is 0.9 cm (normal); 0.45 cm/div reduced scan (466 only). 8.5 kV accelerating potential, normal-mode, 10 kV reduced scan (466 only). GH (P31) Phosphor is standard.

**Graticule** — Internal, nonparallax; variable edge lighting; markings for measurement of risetime.

**Beam Finder** — Compresses trace to within graticule area for ease in determining the location of an off-screen signal. A preset intensity level provides a constant brightness.

**Z-Axis Input** — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 50 MHz.

### STORED WRITING SPEEDS

| Full Scan*1 | 466 | 464 | Storage*2 View Time |
|---|---|---|---|
| Fast Transfer | 150 div/μs | 110 div/μs | >15s |
| Variable Persistance | 0.5 div/μs | 0.5 div/μs | >15s |
| **Reduced Scan*3** | | | |
| Fast Transfer | 3,000 div/μs | N/A | >15s |
| Variable Persistance | 3 div/μs | N/A | >15s |

*1 *Center 6 x 8 division; 0.9 cm/division.*

*2 *These times are at full-stored display intensity; they can be extended at least 25 times using reduced intensity in Save Display Mode.*

*3 *Center 8 x 10 division; 0.45 cm/division.*

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C. Forced air ventilation is provided.

**Altitude** — Operating: To 4600 m (15,000 ft); maximum allowable ambient temperature decreased by 1°C/1000 ft from 5,000 ft to 15,000 ft. Nonoperating: To 15 000 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles.

**Humidity** — Operating and Nonoperating: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, Class 4).

**Shock** — Operating and Nonoperating: 30 g's, ½ sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

### OTHER CHARACTERISTICS

**Amplitude Calibrator**

| | | |
|---|---|---|
| Output Voltage | 0.3 V | 1% +0°C to +40°C |
| Output Current | 30 mA | 2% +20°C to +30°C |
| Frequency | ≈1 kHz | |

**Vertical Signal Output** — CH 1 vertical signal is dc to at least 50 MHz and ≈25 mV/div terminated into 50 Ω, and ≈50 mV/div terminated into 1 MΩ.

**Gate Outputs** — Positive gates from both time bases (≈5 V).

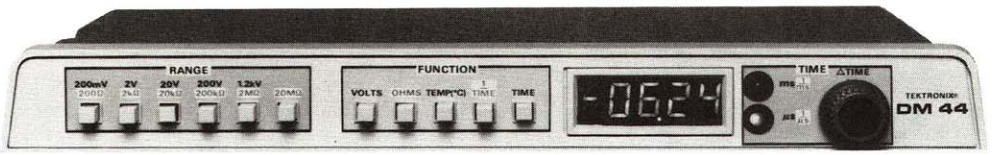
**Power Requirements** — Quick-Change Line Voltage Selector Provides Six Ranges: 110 V, 115 V, 120 V, 220 V, 230 V, and 240 V, each ±10%. 48 Hz to 440 Hz, 100 W maximum at 115 V and 60 Hz. Operation from 12 V to 24 V dc is available with Option 07.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width (with handle) | 330 | 13.1 |
| Height (without pouch) | 159 | 6.2 |
| Depth (with panel cover) | 550 | 21.7 |
| Depth (handle extended) | 597 | 23.8 |
| **Weights ≈** | **kg** | **lb** |
| Net (without panel cover or accessories) | 11.8 | 26.0 |
| Net (with panel cover and accessories) | 13.5 | 29.8 |
| Shipping | 18.8 | 41.5 |

### INCLUDED ACCESSORIES

Two P6062B Probes (010-6062-13); blue accessory pouch (016-0535-02); clear pouch (016-0537-00); CRT light filter (337-1674-01); two 1½ A fuses (159-0016-00); one ¾ A fuse (159-0042-00); ground wire adaptor (134-0016-01); viewing hood (016-0592-00); service manual; operator's manual.




## DM 44
## Differential-Time/DMM Option

**For the 466/464**

**3½ Digit LED Display**

**Time Intervals Accurate to 1%**

**Frequency Accurate to 2%**

**Dc Voltage Measurements Accurate to 0.1%**

**Resistance Accurate to 0.3%**

**Temperature from −55°C to +150°C**

One percent timing measurements were never this easy! With the DM 44 Option time intervals can be read directly from the 3½ digit LED screen. Simply use the Delay Time control and the ΔTime Dial to superimpose the end of the interval on the beginning. Then read its differential time or frequency from the 3½ digit LED panel. It's that simple. Time intervals are accurate to 1% and the frequency of periodic waveforms can be read out with 2% accuracy by simply pushing the 1/Time button.

Compare the DM 44 sequence with the measurement technique you may now be using. Calculating the interval from the CRT may take 10 times as long.

Voltage, resistance, and temperature measurements are also much easier with a DM 44. It measures dc voltage with 0.1% accuracy, resistance with 0.3% accuracy, and temperature from −55°C to +150°C. Previously, you would have needed a separate DMM and digital thermometer in addition to your oscilloscope. Now, these features are combined in one small, inexpensive, integral package.

## CHARACTERISTICS

### TIMING MEASUREMENTS (WITH 464 AND 466)

**Differential Time Delay Accuracy**

| +15°C to +35°C | −15°C to +55°C |
|---|---|
| Within 1% of reading ±1 count | Within 2.5% of reading ±1 count |

**1/Time Accuracy**

| +15°C to +35°C | −15°C to +55°C |
|---|---|
| Within 2% of reading ±1 count | Within 3.5% of reading ±1 count |

### DC VOLTAGE

**Ranges** — 0 to 200 mV, 0 to 2 V, 0 to 20 V, 0 to 200 V, 0 to 1.2 kV.

**Resolution** — 100 μV.

**Accuracy** — Within 0.1% of reading ±1 count.

**Input Resistance** — 10 MΩ for all ranges. Removal of an internal strap increases resistance to ≈1000 MΩ on 200 mV and 2 V ranges.

**Normal-Mode Rejection Ratio** — At least 60 dB at 50 Hz and 60 Hz.

**Common-Mode Rejection Ratio** — At least 100 dB at dc, 80 dB at 50 Hz and 60 Hz.

**Recycle Rate** — ≈3.3 measurements/s.

**Response Time** — Within 0.5 s.

**Maximum Safe Input Voltage** — ±1200 V dc + peak ac between + and common inputs or between + and chassis. ±500 V (dc + peak ac) common floating voltage between common and chassis.

### RESISTANCE

**Ranges** — 0 to 200 Ω, 0 to 2 kΩ, 0 to 20 kΩ, 0 to 200 kΩ, 0 to 2 MΩ and 0 to 20 MΩ.

**Resolution** — 0.1 Ω.

**Accuracy**

| Range | Accuracy |
|---|---|
| 200 Ω | within 0.25% ±1 count + probe resistance |
| 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ | within 0.25% ±1 count |
| 20 MΩ | within 0.3% ±1 count |

**Recycle Rate** — ≈3.3 measurements/s.

**Response Time**

| | |
|---|---|
| 200 Ω through 200 kΩ ranges | within 1 s |
| 2 MΩ ranges 20 MΩ ranges | within 5 s |

**Maximum Safe Input Voltage** — 120 V RMS between + and common inputs.

### TEMPERATURE USING P6430 PROBE

**Range** — −55°C to +150°C.

**Accuracy**

| DM 44 Temperature | P6430 Tip Temperature | Accuracy (Probe Calibrated to DM 44) |
|---|---|---|
| +15°C to +35°C | −55°C to +150°C | ±2°C |
| −15°C to +55°C | −55°C to +125°C<br>+125°C to +150°C | ±3°C<br>±4°C |

### INCLUDED ACCESSORIES

One pair test leads (003-0120-00); one P6430 Temperature Probe (010-6430-00); service manual; operator's manual.

## ORDERING INFORMATION

**466** Storage Oscilloscope ..... **$7,270**

**466 DM 44** Storage Oscilloscope/DMM **$7,920**

**464** Storage Oscilloscope ..... **$6,150**

**464 DM 44** Storage Oscilloscope/DMM **$6,800**

### INSTRUMENT OPTIONS

**Option 01** — Delete DM 44 Temperature Probe (466DM 44, 464DM 44 Only) ..... **−$90**

**Option 04** — EMC Capability ..... **+$200**

**Option 05** — TV Sync Separator (Provides Triggering on TV Field) ..... **+$350**

**Option 07** — External Dc Operation (Not for DM 44) **+$300**

### INTERNATIONAL POWER CORDS AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

### OPTIONAL ACCESSORIES

**1106** — Battery Pack (Used with Option 07) ..... **$1,150**

**1105** — Battery Power Supply (See page 302) ..... **$1,550**

**Mesh Filter** — Improves display contrast in high ambient light. Order 378-0726-01 ..... **$55**

**Protective Cover** — Waterproof vinyl (for 464/466). Order 016-0365-00 ..... **$21**

**Folding Viewing Hood** — Order 016-0592-00 ..... **$12**

**Folding Binocular Hood** — Order 016-0566-00 ..... **$15**

**Polarized Collapsible Viewing Hood** — Order 016-0180-00 ..... **$40**

**K212 Portable Instrument Cart** — For on-site portability. ..... **$330**

**K117 Instrument Shuttle** — For site-to-site portability. Order ..... **$265**

**Rack Adaptor** — (Not for DM 44.) Order 016-0676-00 **$350**

**See page 434 for complete description on carts.**

**A6902A Isolator** — For floating measurements see page 434 for complete description. Order A6902A ..... **$1,985**

### RECOMMENDED CAMERA

**C-30BP Option 01** — General Purpose Camera. Includes 016-0301-01 mounting adaptor/corrector lens. Order C-30BP Option 01 ..... **$1,489**

**For further information see camera section.**

Modification kits for field conversion of existing 466s and 464s to Option 07 or DM 44 equipped scopes are available. These are typically more expensive than when the option is ordered with the instrument. Contact your Tektronix Sales Engineer, Distributor, or Representative for information.

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## 434

**25 MHz at 10 mV/div**

**20 ns/div Sweep Rate with X50 Sweep Magnifier**

**Weighs ≈9.4 kg (20.8 lb)**

A bistable, split-screen storage oscilloscope with a 25 MHz bandwidth, the compact 434 fills many needs. The split screen provides full-screen storage, or upper or lower screen storage, with the other half conventional.

Tektronix 434s are used for maintaining display boards, video monitors, automatic baggage handling systems, X-ray systems, and air-conditioning and heating systems.

## CHARACTERISTICS

### VERTICAL DEFLECTION

**(2 Identical Channels)**

**Bandwidth and Risetime (From 50 Ω Terminated Source, With or Without 10X Probe)** — Dc to at least 25 MHz at 3 dB down*1, 14 ns from 10 mV/div to 10 V/div, decreasing to 15 MHz, 22 ns at 1 mV/div. Low frequency 3 dB down point with ac coupling is 14 Hz or less (<1 Hz with 10X probe).

**Deflection Factor** — 1 mV/div to 10 V/div, accurate ±3%. Uncalibrated, continuously variable between steps and to ≈25 V/div.

**Display Modes** — CH 1 only, CH 2 only (normal or inverted), alternate, chopped (≈100 kHz), added.

**Common-Mode Rejection Ratio** — At least 20 dB at 10 MHz for common-mode signals of 6 div or less.

**Automatic Scale Factor** — Probe tip deflection factors for 1X or 10X coded probes are indicated by lights besides the knob skirts. Ground reference display selectable at probe (when dc coupled).

**Input R and C** — 1 MΩ ±2% paralleled by ≈24 pF.

**Maximum Input Voltage** — Dc Coupled: 250 V (dc + peak ac). Ac Coupled: 500 V (dc + peak ac). In either mode the maximum ac is 500 V p-p at 1 kHz or less.

**Delay Line** — Permits viewing of leading edge of displayed waveform.

*1 *Bandwidth derated to 22 MHz above +30° C.*

### HORIZONTAL DEFLECTION

**Time Base** — 0.2 μs/div to 5 s/div (1-2-5 sequence). X50 magnifier extends fastest sweep rate to 20 ns/div.

**Variable Time Control** — Uncalibrated, continuously variable between steps and to 12.5 s/div.

**Time Base Accuracy*1**

| | +20°C to +30°C | −15°C to +55°C |
|---|---|---|
| Unmagnified | ±3% | ±4% |
| Magnified | ±4% | ±5% |

*1 *Full 10 divisions*

**External Horizontal Input** — Deflection factor is ≈0.5 V/div. Input resistance is ≈50 kΩ.

### TRIGGER

**Modes** — Auto trigger (sweep free-runs in absence of triggering signal, normal trigger, single sweep).

**Trigger Sensitivity and Coupling**

| Coupling | To 5 MHz | At 25 MHz |
|---|---|---|
| Dc Internal | 0.3 div deflection | 1 div deflection |
| Dc External | 50 mV | 125 mV |
| Ac | Requirements increase below 20 Hz | |
| Ac LF Reject | Requirements increase below 50 kHz | |
| Ac HF Reject | Requirements increase above 50 Hz | |

**Sources** — CH 1 only, composite line, external and external ÷10. External trigger level range is at least +2 V to −2 V or +20 V to −20 V.

**External Inputs** — Input R ≈1 MΩ paralleled by 100 pF ÷1 or 70 pF ÷10. 250 V (dc + peak ac).

### DISPLAY

**CRT** — 8 x 10 div (1 div = 0.975 cm) horizontal and vertical divisions further marked in 0.2 div increments. GJ (P1) Phosphor. 4 kV accelerating potential.

**Graticule** — Internal, nonparallax; nonilluminated.

**Beam Finder** — Compresses trace to within graticule area for ease in locating an off-screen signal.

**Z-Axis Input** — Dc coupled, positive going signal decreases intensity, 5 V p-p signal causes noticeable modulation; dc to 20 MHz usable frequency range.

### STORAGE FEATURES

**Display Modes** — Split-screen with storage on upper or lower half of screen with conventional display on other half. Storage on entire screen or conventional display. Independent operation of halves.

**Stored Writing Speed (Center 8 Div)** — Normal, 100 div/ms. Enhanced, increases single-sweep storage writing speed to at least 400 div/ms. (Option 01, 500 div/ms, normal; to 5000 div/ms, enhanced).

**Erase Time** — 300 ms or less.

**Locate** — Beam can be positioned left of the graticule area to determine vertical position of next sweep without disturbing stored display.

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C.

**Altitude** — Operating: To 4600 m (15,000 ft); maximum allowable ambient temperature decreased by 1°C/1000 ft from 5,000 ft to 15,000 ft. Nonoperating: To 15 000 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles.

**Humidity** — Operating and Nonoperating: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.1, class 4).

**Shock** — Operating and nonoperating: 30 g's, ½ sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

### OTHER CHARACTERISTICS

**Amplitude Calibrator** — 0.6 V ±1.0%, 1 kHz ±1.0% (+20°C to +30°C). Output resistance is 575 Ω.

**Power Requirements** — Operates on all voltages from 90 V to 136 V and 180 V to 272 V, 48 Hz to 440 Hz, 60 W maximum. Also operates from 220 V dc to 350 V dc.

### PHYSICAL CHARACTERISTICS

| | Cabinet | | Rackmount | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width (with handle) | 330 | 13.0 | 483 | 19.0 |
| Height (w/o pouch) | 142 | 5.6 | 133 | 5.3 |
| Depth | 475 | 18.7 | 457 | 18.0 |
| **Weight ≈** | **kg** | **lb** | **kg** | **lb** |
| Net | 9.4 | 20.8 | 10.5 | 23.1 |
| Shipping | 13.6 | 30.0 | 22.0 | 49.0 |

### INCLUDED ACCESSORIES

Two P6105 Probes (010-6105-03); accessory pouch (016-0165-00); service manual; operator's manual. Rack models also include mounting hardware and slide out assemblies, but not pouch.

## ORDERING INFORMATION

**434** Storage Oscilloscope ..... **$5,620**
**R434** Rackmount Storage Oscilloscope ..... **$5,925**
**Option 01** — Increased Writing Speed ..... **+$450**

### OPTIONAL ACCESSORIES

**Probes**

| Probe Type | Attenuation | Input Impedance | Bandwidth*1 |
|---|---|---|---|
| P6062B 6 ft | 1X | 1 MΩ 5 pF | 6.7 MHz |
| | Switchable 10X | 10 MΩ 14 pF | 25 MHz |
| P6122 1.5 m | 10X | 10 MΩ 11pF | 25 MHz |
| **Current Probe** | **Calibration** | **Insertion Impedance** | **Bandwidth with 434** |
| P6022 5 ft | 1 mA/mV 10 mA/mV (Selectable) | 0.03 Ω at 1 MHz Increasing to 0.2 Ω at 120 MHz | 25 MHz |

*1 *Bandwidths are measured at the upper −3 dB, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth.*

**1105 Battery Power Supply** — (See page 302.) ..... **$1,550**
**Mesh Filter** — Improves contrast and EMC filtering. Order 378-0682-00 ..... **$48**
**Portable to Rackmount Assembly** — Includes hardware for standard 434 in 19 in rack mounting. Order 016-0272-00 ..... **$250**
**Folding Polarized Viewing Hood** — Order 016-0180-00 ..... **$40**
**K212 Portable Instrument Cart** — For on-site portability. **$330**
**K117 Instrument Shuttle** — For site-to-site portability. **$265**
**See page 429 for complete description on carts.**

**A6902A Isolator** — For floating measurements see page 434 for complete description. Order A6902A ..... **$1,985**

### RECOMMENDED CAMERA

**C-30BP Option 01 General Purpose Camera** — Includes 016-0301-01 mounting adaptor/corrector lens. Order C-30BP Option 01 ..... **$1,489**

**For further information see camera section.**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## 314

**10 MHz at 1 mV/div**

**100 ns/div Sweep Rate with X10 Sweep Magnifier**

**Stored Viewing Time to 4 Hours**

**Integrate Mode for Intensifying Fast Risetime, Low Repetition Rate Signals**

**Operates from Ac Line, 12 V Dc, or 24 V Dc**

**Small Size, Weighs ≈4.7 kg (10.5 lb)**

The 10.5 pound, bistable storage 314 provides 1 mV/div sensitivity at 10 MHz, with a four hour viewing time. With long-term storage, you can use the 314 to monitor signal lines where undesired transients are suspected.

For fast risetime, low repetition rate signals, an integrate mode increases the intensity of the stored trace.

Compact size and operation from ac or external dc source mean that the 314 will easily go wherever you need a storage oscilloscope.

Combined function controls, color coding, and functional front-panel layout make the 314 easy to use. Probes mount on the side, permitting an uncrowded front panel and large CRT.

The 1 mV/div sensitivity is particularly useful for measurement of transducer signals such as those from magnetic recording heads. An autoerase mode, with variable erase period from 1 second to 5 seconds, enhances the ability of the 314 to make measurements on slowly changing analog signals such as those from a pressure transducer. Other applications for the 314 occur in industrial control systems, biophysical instrumentation, communication terminals, POS terminals, computer peripherals, and communication systems.

## CHARACTERISTICS

### VERTICAL DEFLECTION

**Bandwidth and Risetime** — Dc to at least 10 MHz. Risetime: 35 ns or less for a 4 div step input. For ac coupling, the lower 3 dB point is 10 Hz or less.

**Deflection Factor** — 1 mV/div to 10 V/div (1-2-5 sequence), accurate ±3%. Continuously variable between steps and to at least 25 V/div (uncalibrated).

**Display Modes** — CH 1, CH 2 (normal or inverted), chopped, alternate, added, and X-Y.

**Input R and C** — 1 MΩ paralleled by ≈47 pF.

**Maximum Input Voltage** — Ac or dc coupled, 300 V (dc + peak ac).

**Delay Line** — Permits viewing leading edge of displayed waveform.

**Amplitude Calibrator** — 0.5 V accurate ±1% from 20°C to 30°C, ±2% from −15°C to +55°C.

### HORIZONTAL DEFLECTION

**Time Base** — 1 μs/div to 5 s/div. X10 magnifier extends sweep rate to 100 ns/div.

**Variable Time Control** — Uncalibrated, continuously variable between steps and to at least 12.5 s/div.

**Time Base Accuracy*[1]**

| Unmagnified | |
|---|---|
| 1 μs/div to 0.2 s/div | ±3% |
| 0.5 s/div to 5 s/div | ±4% |
| **Magnified** | |
| 50 ms/div to 0.5 s/div | ±5% |
| 0.5 μs/div to 20 ms/div | ±4% |
| 0.1 μs/div and 0.2 μs/div | ±5% |

*[1] Center 8 divisions*

### TRIGGER

**Modes** — Normal (sweep generator requires a trigger to generate a sweep). Automatic (minimizes trigger adjustment). Sweep generator free-runs in the absence of a trigger. Single sweep (one sweep is initiated by the first trigger after a reset).

**Trigger Sources** — Internal: CH 1, CH 2 or composite, external.

**Sensitivity and Coupling**

| Coupling | 1 MHz | 10 MHz |
|---|---|---|
| Dc Internal | 0.3 div deflection | 1 div deflection |
| Dc External | 150 mV | 500 mV |
| Ac | Requirements increase below 30 Hz | |
| Ac LF Reject | Requirements increase below 50 kHz | |

### X-Y OPERATION

**Input** — X-axis input is via the external horizontal input connection. Both CH 1 and CH 2 provide vertical inputs. Using chopped mode, two simultaneous X-Y displays can be obtained.

**X-Axis Deflection Factors** — Continuously variable from 20 mV/div to 2 V/div. Bandwidth, dc to at least 200 kHz.

**Input Impedance** — 1 MΩ ±2% paralleled by ≈62 pF.

### DISPLAY

**CRT** — 8 x 10 div (0.6 cm/div) display. GX (P44) Phosphor. 2 kV accelerating potential.

**Graticule** — Internal, nonilluminated. Vertical and horizontal centerlines marked in 5 minor div per major 0.6 cm/div.

**Z-Axis Input** — Range +5 V to +20 V (dc coupled) with a 100 kHz or greater usable frequency range. Maximum input voltage, 50 V (dc + peak ac).

### STORAGE FEATURES

**Display Modes** — Direct view, bistable storage, and nonstore modes. Enhance mode to increase stored writing rate in the single sweep mode. Autoerase mode to automatically erase stored display after each sweep. Viewing time before autoerase can be varied from 1 s or less to at least 5 s. Integrate mode increases stored brightness of very fast repetitive signals.

**Stored Writing Speed** — Normal, at least 80 div/ms. Enhanced, increases to at least 400 div/ms (250 cm/ms) in enhanced mode.

**Erase Time** — 300 ms.

### AC POWER REQUIREMENTS

**Line Voltage Ranges** — 90 V ac to 130 V ac or 180 V ac to 264 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Power Consumption** — 29 W maximum at 115 V ac.

**External Dc Source** — +11 V dc to +14 V dc or +22 V dc to +28 V dc.

**Dc Current Drain** — 1.6 A at +12 V or 0.8 A at +24 V.

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Operating: −15°C to +55°C. Nonoperating: −40°C to +75°C.

**Altitude** — Operating: 6000 m (20,000 ft) maximum, decrease maximum temperature by 1°C/1000 ft from 5000 ft to 20,000 ft. Nonoperating: 15 000 m (50,000 ft) maximum.

**Vibration** — Operating: 15 minutes along each of the three major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles.

**Humidity** — Nonoperating: 5 cycles (120 hours) of MIL-Std-202D, Method 106C. Omit freezing and vibration and allow a post-test drying period at 25°C ±5°C and 20% to 80% relative humidity.

**Shock** — Operating and Nonoperating: 30 g's, ½ sine, 11 ms duration each direction along each major axis. Total of 12 shocks.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width (with handle) | 236 | 9.3 |
| Height (without pouch) | 112 | 4.4 |
| Depth (handle not extended) | 347 | 13.6 |
| Depth (handle extended) | 448 | 17.6 |
| **Weight ≈** | **kg** | **lb** |
| Net (without accessories) | 4.7 | 10.5 |
| Shipping | 7.6 | 17.0 |

### INCLUDED ACCESSORIES

Two P6149 10X probes (010-6149-03); carrying case and pouch (016-0612-00); strap (346-0131-02); external dc cable assembly (012-0406-00); two 1.6-A fuses (159-0098-00); two 0.8-A fuses (159-0132-00); two 0.15-A fuses (159-0130-01); three 0.16-A fuses (159-0131-00); service manual; operator's manual.

## ORDERING INFORMATION

**314** Storage Oscilloscope ..... **$4,050**

The SONY®/TEKTRONIX® 314 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 314 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

### RECOMMENDED CAMERA

**C-30BP Option 01** General Purpose Camera ..... **$1,489**

**Camera Adaptor** — Required to mount the C-30BP to the 314. Order 016-0327-01 ..... **$170**

**For further information see camera section.**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## 214

**500 kHz, 1 mV/div to 50 V/div**

**Internal Battery**

**Integral 1 MΩ Probe**

**Weighs ≈1.6 kg (3.5 lb)**

The 214 features these signal acquisition capabilities: bandwidth to 500 kHz with deflection factors from 1 mV/div to 50 V/div. It is lightweight (only 3.5 pounds) and compact (3 x 5.3 x 9.5 inches). The 214 offers bistable storage capabilities. This is useful for viewing nonrepetitive or slow moving signals.

Built of impact-resistant plastic and fully self contained, this miniature portable is ideal for applications in severe environments. And it permits "floating" measurements since it is double insulated and can be elevated to 700 V (dc + ac) above ground when operated from batteries. Although insulated, normal caution should be observed when connecting the oscilloscope probe to the test point.

The 214 features integral probes that are color matched with the vertical deflection controls to minimize measurement error. The probes have their own storage space and are part of the instrument—you can't forget and leave them behind. Clip-on 10X attenuators are available for higher voltage applications.

Trigger level and slope functions are simplified to one rotary control on the side of the unit. A convenient neckstrap is an included accessory, freeing both hands to perform other tasks.

In the single sweep mode the 214 can be set to wait for, then record, a single event. With this feature, the scope's sweep circuit is armed and will wait for the signal to arrive before it runs. When the signal occurs, the sweep runs once. When combined with storage, this provides the unique capabilities of automatically waiting for an event and then storing it for subsequent viewing.

## CHARACTERISTICS

### VERTICAL DEFLECTION

**Bandwidth** — Dc to at least 500 kHz from 10 mV/div to 50 V/div, reducing to at least 100 kHz at 1 mV/div. Lower −3 dB point ac coupled is ≈2 Hz.

**Deflection Factors** — 1 mV/div to 50 V/div (1-2-5 sequence), accurate ±5%. Uncalibrated, continuously variable between steps to at least 125 V/div.

**Display Modes** — CH 1 only, CH 2 only, or CH 1 and CH 2 chopped (≈ chop rate — 40 kHz) from 500 ms/div to 2 ms/div of time base, alternate from 1 ms/div to 5 μs/div of time base.

**Input R and C** — ≈1 MΩ paralleled by ≈160 pF from 1 mV/div to 50 mV/div; and 140 pF from 100 mV/div to 50 V/div.

**Maximum Input Voltage**[*1]

| | |
|---|---|
| 1 mV/div to 50 mV/div | 600 V (dc + peak ac) ac not over 2 kHz |
| 0.1 V/div to 50 V/div | 600 V (dc + peak ac) 600 V p-p ac; 5 MHz or less |

*[*1] 1X Probe Only*

### HORIZONTAL DEFLECTION

**Time Base** — 5 μs/div to 500 ms/div, accurate ±5%.

**Variable Magnifier** — Increases each sweep rate X5 with a maximum sweep speed of 1 μs/div.

**External Horizontal Input** — (CH 1) 1 mV/div to 50 V/div ±10%; dc to 100 kHz: X-Y phasing to 5 kHz <3°. Input characteristics same as CH 1.

**Maximum External Horizontal Input Voltage and Impedance** — Same as for vertical inputs.

**Input Impedance** — R and C, 1 MΩ paralleled by ≈30 pF.

### TRIGGER

**Trigger Modes (Automatic or Normal)** — Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

**Trigger Sensitivity and Coupling**

| Dc Coupling | To 500 Hz |
|---|---|
| Internal (w/composite trigger source) | 0.2 div |
| Internal (w/CH 2 trigger source) | 0.2 div |
| External | 1 V |

**Maximum External Trigger Input Voltage** — 8 V (dc + peak ac), 16 V (p-p) at 500 kHz or less.

**Single Sweep** — Sweep generator produces one sweep when trigger is received.

### DISPLAY

**CRT** — Bistable storage, 6 x 10 div (0.52 cm/div) display. GX (P44) Phosphor.

**Graticule** — Internal, black line, nonilluminated.

### STORAGE FEATURES

**Stored Writing Speed** — Normal, at least 80 div/ms. Enhanced, increases single-sweep storage writing speed to at least 500 div/ms. Enhance is automatic from 0.1 ms to 5 μs/div in single sweep.

**Stored Luminance** — At least 8 fL at 25°C.

**Storage Viewing Time** — ≈1 hour.

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Operating (Battery Only): −15°C to +55°C. Charging or Operating From Ac Line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

**Altitude** — Operating: 7600 m (25,000 ft), decrease maximum temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 15 000 m (50,000 ft).

**Vibration** — Operating and Nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

**Humidity** — 5 cycles (120 hours) to 95% relative humidity, referenced to MIL-E-16400F.

**Shock** — Operating and Nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

### OTHER CHARACTERISTICS

**Power Sources** — Internal NiCd batteries provide ≈3.5 to 5 hours operation (≈2.5 to 3.5 hours in 214 stored mode) for a charging and operating temperature between +20°C and +30°C. Internal charger charges the batteries when connected to an ac line with instruments turned off. Battery operation is automatically interrupted when battery voltage drops to ≈10 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. Extended charge times will not damage the batteries.

A pilot light battery-charge indicator light will extinguish when oscilloscope has about 5 minutes of operating time remaining in the batteries.

**External Ac Source** — 110 V to 126 V, 58 Hz to 62 Hz, 3 W. Can be operated at 104 V to 110 V with resulting slow discharge of internal batteries.

**Insulation Voltage** — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries, with the line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4 times line voltage + dc + peak ac not to exceed 350 V.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 133 | 5.3 |
| Height | 76 | 3.0 |
| Depth | 241 | 9.5 |
| **Weight≈** | **kg** | **lb** |
| Net (without accessories) | 1.6 | 3.5 |
| Shipping | 3.2 | 7.0 |

### INCLUDED ACCESSORIES

Viewing hood (016-0199-01); carrying case (016-0512-00); two 4-A fuses (159-0121-00); identification tags (000-7983-00); identification tag (334-2614-00); carrying strap (346-0104-00); service manual; operator's manual.

## ORDERING INFORMATION

**214** Dual-Trace Storage Oscilloscope, Includes Batteries and Probes ..... **$2,600**

### POWER OPTIONS

**Option 01** — For 220 V to 250 V (48 Hz to 52 Hz) Includes Batteries ..... **NC**

**Option 02** — For 90 V to 110 V (48 Hz to 52 Hz) Includes Batteries ..... **NC**

### OPTIONAL ACCESSORIES

**10X Attenuator Package** — A slip-on tip to provide lower circuit loading (4.4 MΩ, ≈20 pF) and higher maximum input voltage 1000 V (dc + peak ac). Includes: flex tip (206-0060-00); 10X attenuator (010-0378-01); pincher tip (013-0071-00); banana tip (134-0013-00); IC adaptor (206-0203-00). Order 010-0378-01 ..... **$60**

**Alligator Clip Kit** — A pair of alligator clips that allow connecting the probe (or optional 10X attenuator) and ground lead to large (up to ⅜ in) conductors. Includes: 6-32 to probe adaptor (103-0051-01); red clip (015-0229-00); yellow clip (015-0230-00). Order 015-0231-00 ..... **$21**

**Probe-Tip** — To BNC Panel Connector Adaptor. Order 013-0084-01 ..... **$8.00**

**Probe-Tip** — To BNC Cable Adaptor. Order 103-0096-00 ..... **$11.00**

**Power Cable Adaptor Assembly** — A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied. Order 161-0077-01 ..... **$9.00**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## T912

**10 MHz at 2 mV/div**

**250 cm/ms Stored Writing Speed**

**50 ns/div Sweep Rate (with X10 Sweep Magnifier)**

**8 x 10 cm Bistable Storage CRT**

**Weighs ≈7.9 kg, (17.5 lb)**

**Differential Input Option**

The T912 Storage Oscilloscope is well suited for a wide range of applications in education and industry. As a training aid in basic electricity and electronics courses, the storage feature is highly useful in creating visual representations of electrical signals. In physics and engineering courses, storage permits the user to capture and display single-shot events like the pressure curve generated in the compression chamber of an engine or the stress-strain characteristics of a material undergoing destructive testing.

The T912 has similar industrial applications, where it can also be used to compare input vs feedback signals in servo-mechanisms for shock and vibration analysis, and countless other transducer-aided measurements.

Besides bistable storage, the T912 offers other features seldom found in economy-model oscilloscopes including a delay line, that allows you to view the leading edge of fast-rising signals, a 12-step calibrated vertical attenuator and constant bandwidth throughout the sensitivity range of 10 V to 2 mV per centimeter. Additional features include 19 calibrated sweep rates ranging from 0.5 s to 500 ns/cm, 3% amplitude and timing accuracy; and minimal corner shift over a broad vertical dynamic range.

The T912 may be ordered with a differential input option. In Diff mode, the T912 displays the difference between CH 1 and CH 2 signals. The CH 2 signal is automatically inverted. The algebraic sum of the CH 1 signal and the inverted CH 2 signal is then displayed on the CRT.

## CHARACTERISTICS

### VERTICAL SYSTEM

**Mode Selection** — CH 1: Displays only the CH 1 signal. CH 2: Displays only the CH 2 signal. Dual Trace: Displays CH 1 and CH 2 signals simultaneously. Alternate or chopped mode is automatically selected by the Sec/Div control setting, chopped mode is selected for settings ≥1 ms/div, alternate for settings ≤500 μs/div. Trigger is derived from CH 1 signal only.

**Deflection Factor Range** — 2 mV/div to 10 V/div in 12 steps in a 1-2-5 sequence. Continuously variable between settings, to at least 25 V/div.

**Accuracy**

| | |
|---|---|
| +20°C to +30°C | Within 3% |
| 0°C to +45°C | Within 4% |

**Frequency Response** — Dc to at least 10 MHz (measured at −3 dB).

**Risetime** — 35 ns or less.

**Chopped Mode Repetition Rate** — ≈250 kHz.

**Input Resistance** — ≈1 MΩ.

**Input Capacitance** — ≈30 pF.

**Maximum Input Voltage** — Dc Coupled: 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less. Ac Coupled: 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

**Delay Line** — Permits viewing edge of displayed waveform.

### HORIZONTAL SYSTEM

**Calibrated Range** — 0.5 s/div to 0.5 μs/div in 19 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends maximum sweep rate to 50 ns/div.

**Accuracy**

| | Unmagnified | Magnified |
|---|---|---|
| +20°C to +30°C | Within 3% | Within 5% |
| 0°C to +45°C | Within 4% | Within 6% |

**Trigger Modes** — Auto: Permits normal triggering on waveforms with repetition rate of at least 20 Hz. Sweep "free-runs" in the absence of adequate trigger signal, or one with a repetition rate below 20 Hz. Normal: Permits normal triggering. Sweep does not run in the absence of an adequate trigger signal. Single Sweep: Displays one sweep only. Sweep cannot be triggered again until reset. Slope + Out − In: Sweep is triggered on the positive/negative-going slope of the triggering waveform. Level: Variable control selects the amplitude point on the trigger signal when sweep triggering occurs.

**Trigger Sensitivity** — Auto and Normal: 0.5 div internal or 100 mV external from 2 Hz to 5 MHz, increasing to 1.5 div internal or 150 mV external at 10 MHz.

**External Trigger Input** — Maximum Input: 400 V (dc + peak ac) 800 V p-p ac at ≤1 kHz. Input Resistance: ≈1 MΩ. Input Capacitance: ≈30 pF.

### X-Y OPERATION

**Sensitivity, Variable Magnifier** — ≈100 mV/div (X10 magnifier), ≈1 V/div (X1 magnifier), for X; Y is adjusted by vertical control.

**X-Axis Bandwidth** — Dc to at least 1 MHz (measured at −3 dB).

**Input Resistance** — ≈1 MΩ.

**Input Capacitance** — ≈30 pF.

**Phase Difference Between X and Y Axis Amplifiers** — Within 5° from dc to 50 kHz.

### CRT STORAGE DISPLAY

**Writing Rate** — At least 25 cm/ms.

**Enhanced Writing Rate** — At least 250 cm/ms.

**Display Area** — 8 cm x 10 cm, internal graticule.

**Storage Phosphor** — GJ (P1).

**Beam Finder** — Locates off-screen display.

**Nominal Accelerating Potential** — ≈2.76 kV.

### AC POWER REQUIREMENT

**Line Voltage Ranges** — HI-LO range accessible externally; 110 V to 120 V, 220 V to 240 V line selector visible but not accessible externally.

**100 V to 120 V Range** — HI: 108 V RMS to 132 V RMS. LO: 90 V RMS to 110 V RMS.

**220 V to 240 V Range** — HI: 216 V RMS to 250 V RMS. LO: 198 V RMS to 242 V RMS.

**Line Frequency** — 50 Hz to 60 Hz.

**Power Consumption** — 65 W maximum, 0.6 A maximum, at 120 V, 60 Hz.

### PROBE ADJUST

**Output Voltage** — ≈0.5 V.

**Repetition Rate** — ≈1 kHz.

### Z-AXIS INPUT

**Sensitivity** — 5 V causes noticeable modulation.

**Usable Frequency Range** — Dc to 5 MHz.

**Input Impedance** — ≈10 kΩ.

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Nonoperating: −55°C to +75°C. Operating: 0°C to +45°C.

**Altitude** — Nonoperating: 15 000 m; (50,000 ft). Operating: 4600 m; (15,000 ft) maximum. Operating temperature decreased 1°C/304.8 m (1,000 ft) above 1524 m (5,000 ft).

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 180 | 7.1 |
| Height | 254 | 10.0 |
| Depth | 475 | 18.7 |
| **Weight ≈** | **kg** | **lb** |
| Net (with panel cover) | 8.2 | 18.0 |
| Net (without panel cover) | 7.9 | 17.5 |

### INCLUDED ACCESSORIES

3.5 ft P6006 10X Probe (010-0127-00); 2 m P6006 10X Probe (010-0160-00); service manual; operator's manual.

## ORDERING INFORMATION

**T912** — Storage Oscilloscope ..... **$2,255**

**Option 01** — Differential Input ..... **+$110**

### INTERNATIONAL POWER CORDS AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

### OPTIONAL ACCESSORIES

**Protective Front Panel Cover** — Snaps over the oscilloscope front panel to protect controls during transport or storage. Molded from high-impact-resistant plastic. Storage compartment for two probes and cables is built into inner side. Order 016-0340-00 ..... **$20**

**Dust Cover/Rain Jacket (Not Shown)** — Provides protection against dust accumulation when not in use, and against rain and snow during transportation. Constructed of 15 mil tough durable vinyl. An opening at the top allows access to the oscilloscope handle. Order 016-0361-00 ..... **$20**

**C-5C Camera (Not Shown)** — Order C-5C Option 03 .. **$495**

**P6122** — 10X Passive Probe. Order 010-6122-01 ..... **$77**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

# AUTOMATED TEST SYSTEMS AND INSTRUMENTS

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Tektronix offers a variety of programmable measurement instruments to meet your measurement needs. Starting with a wide performance base of GPIB compatible waveform digitizers, with capabilities up to 14 GHz. And, with the 7D20 digitizer plug-in, your existing Tektronix 7000 Series oscilloscope can become a GPIB programmable waveform digitizer—another example of our designed-in commitment to expandability.

Plus, we have a broad range of other GPIB programmable instruments to complete your system—signal and power sources, measurement devices, switchers, spectrum analyzers, multifunction interface units. And they are all supported by a selection of instrument controllers, peripherals, and software.

We provide extensive and ongoing documentation—hardware and software manuals, controller programming guides, instrument interfacing guides, application notes, even a regular newsletter on signal processing and instrument control. In addition, an instrumentation software library provides programs to help you develop measurement software to solve your measurement problems.

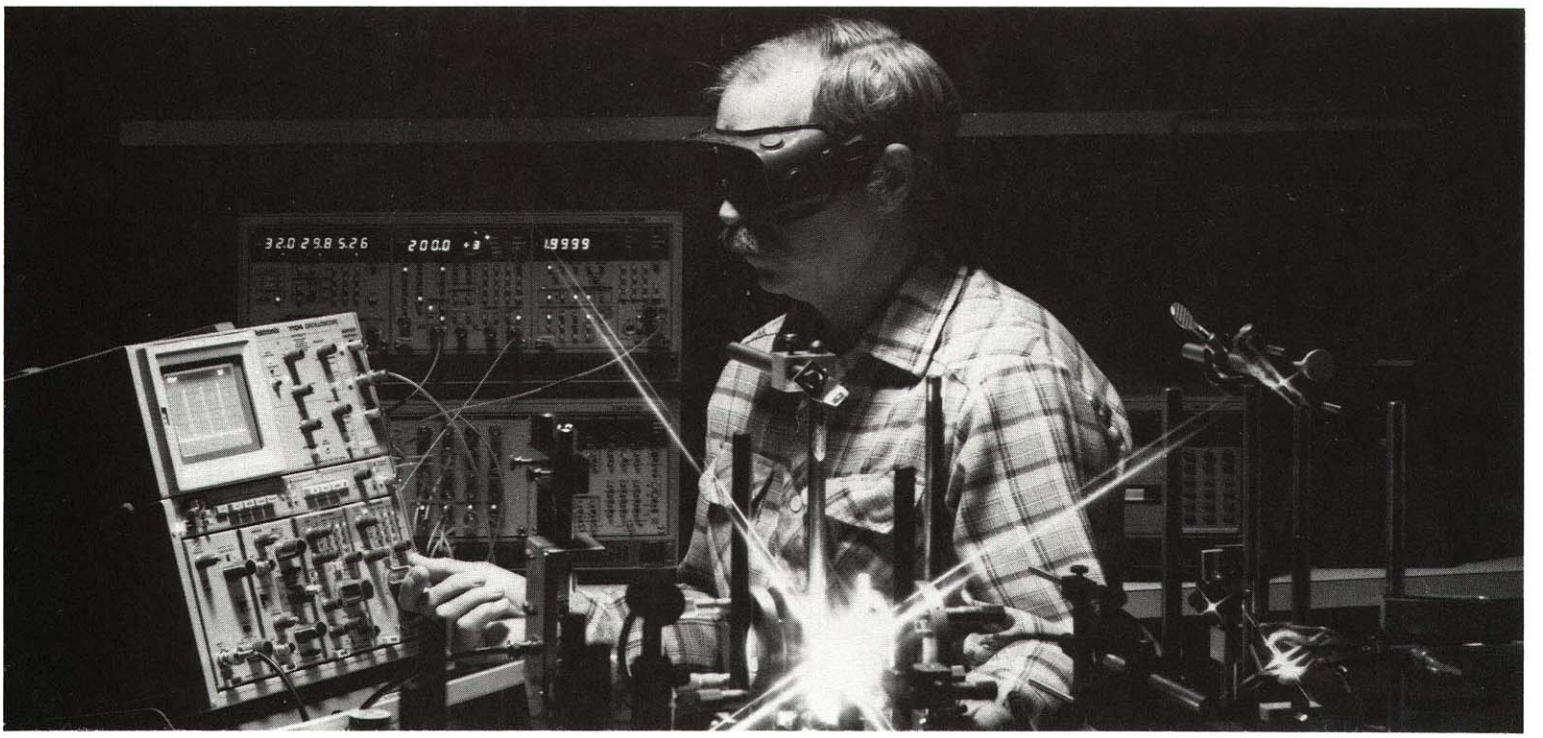
**Configurability**

Tek systems offerings afford maximum flexibility, right down to the number of ways in which they may be configured.

1. Individual systems components are orderable separately and include instrument interfacing guides, documentation, and in some specific cases, application software available through the Tektronix Instrument Software Library.
2. Preconfigured measurement packages (MP) make it easy to purchase the most-needed components in a packaged system that you integrate and install yourself. Instruments contained in measurement packages carry the normal, stand-alone instrument warranty and do not include on-site installation.
3. Factory-integrated measurement systems (MS) are, in many cases, a cost-effective alternative to developing systems yourself. They are assembled and tested at our factory and include on-site installation, 90-day on-site system warranty, training credit and system checkout software.
4. Custom systems are generally modified/expanded versions of our standard packages and include integration, checkout software, on-site installation and warranty. They do not include device-specific application software.

Tek documentation is extensive and on-going. It includes hardware and software manuals, programming guides, interfacing guides, application notes, even a regular newsletter on instrument control and signal processing.

Whatever your needs, from a single GPIB instrument to a complete measurement system, we're sure you'll find the right measure of performance in the pages that follow. Take the time to evaluate your own unique needs —and our uniquely personal solutions. You'll be making an investment in performance that will pay dividends for years.



# PROGRAMMING EASE . . .

## Another Order of Magnitude in Measurement Convenience

### Tektronix *Standard Codes and Formats...* A Commitment to Compatibility

**Tektronix Programmable Instruments Speak Your Language**

With Tektronix programmable instruments, compatibility is the key. And it's more than just IEEE Standard 488 compatibility. It's total system compatibility, from configuring to programming. This higher level of compatibility is achieved through conformance to the additional standard of Tektronix *Standard Codes and Formats*. Tektronix *Standard Codes and Formats* extend compatibility through:

—An ASCII-coded language for easy, English-like programming.
—Command names that are descriptive abbreviations of instrument functions for simple and direct instrument control.
—Universal message and data formats for instrument-to-instrument consistency.

In short, Tektronix programmable instruments speak a system language that is the same as your language.

Need to set your power supply to 5 volts?

It's easy with the TM 5000 Series PS 5010 Programmable Power Supply. Just send the message VPOS 5 over the IEEE Standard 488 Bus to the power supply, and it will change its positive output to 5 volts.

Want to set the negative supply to −9 volts? Just send VNEG 9, or even VNEG −9. All Tektronix programmable instrument commands are simple, English abbreviations for the instrument functions, with direct matches to the front-panel control labels where appropriate. So, if you know how to operate the instrument, you essentially know what commands to send it.

What could be simpler than DCV .2 to change your TM 5000 DM 5010 Programmable Multimeter to the 200 mV range for dc voltage measurements? Or ACV 2 to switch it to the 2 V range for ac measurements? But then, you may not always be sure of the range you need. So just send DCV or ACV without specifying the range, and the multimeter will auto-range to give you the best measurement. You don't have to learn a new language to speak to an instrument or understand instrument control messages—they're self documenting.

**Getting Your Message Across**

It doesn't take long to become familiar with the command set for any Tektronix programmable instrument. And, once you have that familiarity, you'll want to begin actually programming for automated measurements. First, though, you'll need to know something about IEEE Standard 488 Bus communication.

IEEE Standard 488 specifies overall bus functions, leaving many implementation options to designer discretion. One option is how controllers and instruments signal message endings to each other. Some controllers end messages by asserting End Or Identify (EOI) concurrent with sending the last character of a message, others by adding a line feed (LF) character and asserting EOI concurrent with that. For compatibility, your instruments and controller must use the same message termination mode.

Whatever your choice of IEEE Standard 488 instrument controller, Tektronix programmable instruments are designed for compatibility. A switch on each Tektronix programmable instrument lets you match it to your controller by selecting the EOI only or EOI/LF message termination mode. But, if you've chosen a Tektronix controller, you won't have to bother with this switch. All Tektronix-supplied instrument controllers use EOI only, and all Tektronix programmable instruments are shipped set for EOI only.

Along with the Message Terminator switch, you'll also find that Tektronix programmable instruments have a bank of at least five additional switches or front panel push buttons to set the instrument's primary bus address.

For an IEEE Standard 488 system to work, each instrument on the bus must have a different address. Valid addresses range from 0 to 30, with 0 reserved in some cases for the controller. Before connecting your Tektronix programmable instrument to the IEEE Standard 488 Bus, make sure each instrument is set to a different address. For most instruments, address checks can be done with a front-panel button. Pressing the button causes the address to appear on the instrument's display. Some instruments also display their message terminator setting.

The primary address links the controller to a specific instrument. For example, when using a Tektronix 4041 System Controller with 4041 BASIC Software, just primary addresses are used. 4041 BASIC automatically converts primary addresses to talk and listen addresses. For example, a 4041 BASIC statement to send VPOS 5 to a PS 5010 Programmable Power Supply with a primary address of 22 would have the following format:

```
PRINT #22:"VPOS 5"
```

PRINT is the 4041 BASIC statement for sending a message to an instrument. The instrument's primary address, 22 in this case, is always preceded in the statement by an # symbol and followed by a colon. The instrument message, VPOS 5, follows the colon and is always enclosed in quotes. Since the instrument will be receiving the message, PRINT causes the primary address to be automatically incremented to a listen address.

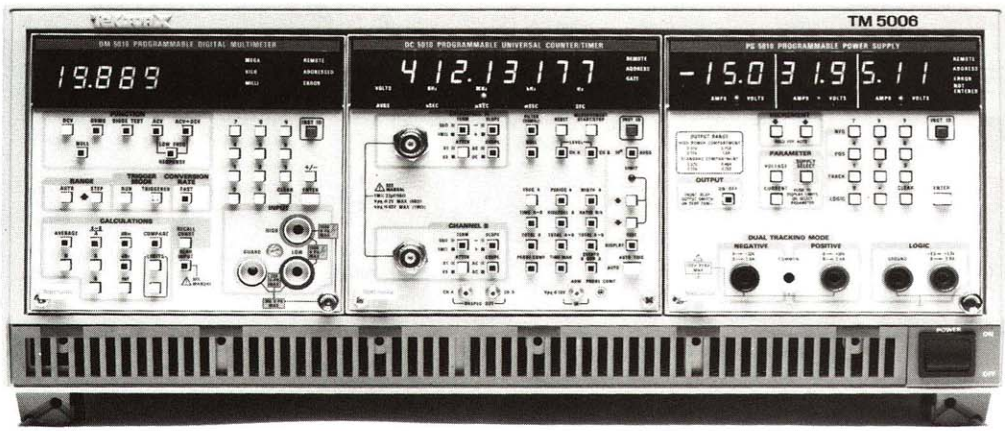
Keep in mind, though, PRINT #22:"VPOS 5" is a statement format specific to 4041 BASIC. Other instrument controllers and software packages may use different statement formats, however the device dependent message is always the same. For example, Put "VPOS 5" into #22 does the same thing in TEK SPS BASIC.

**We Interrupt This Message For a Brief Program**

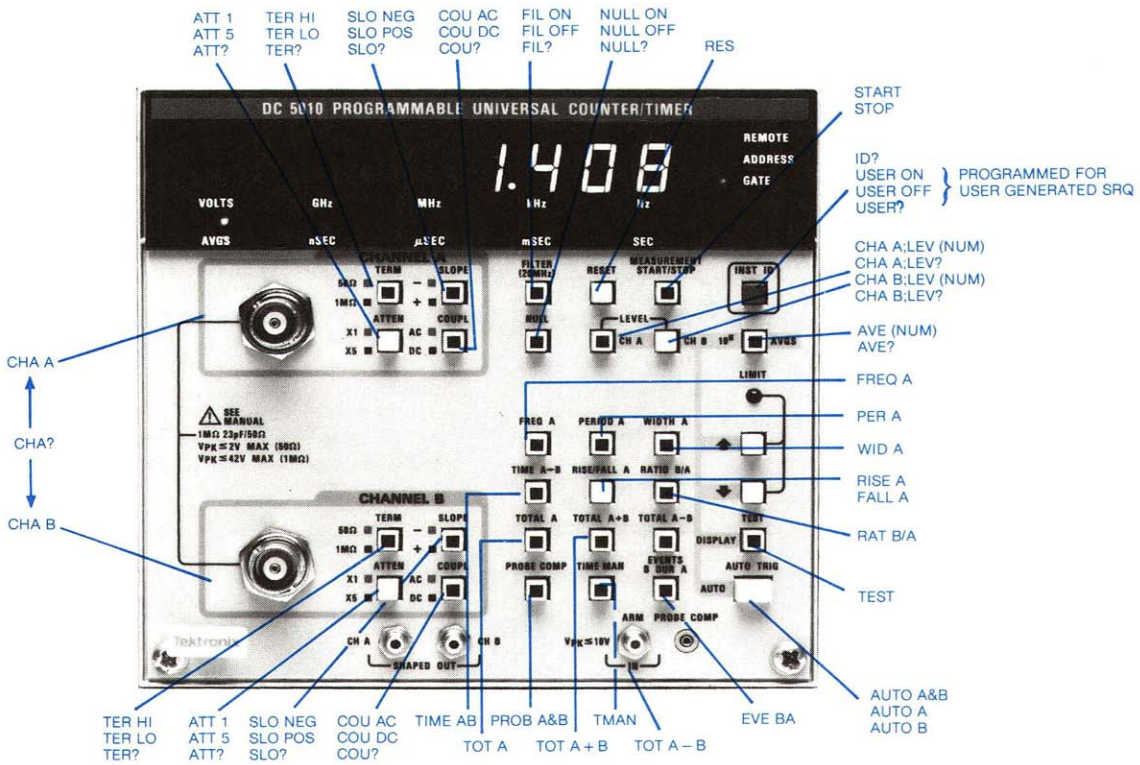
In addition to being easy to program, Tektronix programmable instruments are friendly and informative in respect to sending SRQ interrupts.

With the basic message format in mind, you are ready to begin sending messages to your instruments. However, you should be aware that your instruments can occasionally interrupt what you are doing by asserting what is called an SRQ (Service Request).

On some Tektronix programmable instruments, a front-panel button can also be programmed to generate an SRQ when pressed. This manually generated SRQ is a convenient way for you to interrupt and interact with a measurement program while it is running.




*TM 5000: IEEE Standard 488 compatibility in an attractive, high-density package for minimum use of bench top or system rack space.*




*Tektronix **Standard Codes and Formats** mean friendly "front panel" commands for easy programming.*

This can be done with a serial poll, which is demonstrated in the following 4041 BASIC program example:

```
100 ON SRQ(1) THEN GOSUB SRQHAN
110 PRINT #16:"ACV"
120 PRINT #10:"TR HOLDNEXT ON"
130 .
140 .
150 .
1000 SRQHAN: POLL STATUS,ADDRESS;16;10
1010 RESUME
```

Line 100 in the above example sets up a condition that calls the SRQ handler routine "SRQHAN" whenever an SRQ is asserted. In the absence of an SRQ, the normal path of the program is taken. However, on an SRQ, the program branches to the SRQHAN subprogram, which contains a Poll statement. The Poll statement checks each instrument in the order of listed addresses to find the one asserting SRQ. When it finds the instrument with SRQ asserted, it services the SRQ by reading the instrument's status message into the status variable (STATUS in line 1000). Also, the instrument's address is placed in variable ADDRESS. (From these two variables, you can then tell which instrument asserted SRQ and why.) When the Poll completes, the Resume in line 1010 causes program execution to return to where it was when the SRQ caused the interrupt.

In an actual programming situation, you may want to check the status code variable, STATUS, and base some action on its value before returning to the main programs. To make this easier, Tektronix programmable instruments all use the same status codes for universal conditions. For example, no matter what Tektronix programmable instrument you are using, 66 is the code for operation complete. A full list of status codes and their meanings is provided in each instrument manual.

Tektronix programmable instruments also have an error code scheme that allows individual instruments to expand on the universal system status codes. This expansion is the result of an extensive message decoding system that checks for syntax errors, illegal combinations, etc., before messages are allowed to affect instrument operation. Illegal setups are prevented, and specific, rather than generalized, error codes are available for each instrument. These error codes can be read over the IEEE Standard 488 Bus by sending the instrument an error query message (ERR?) or the event query message (EVENT?). Together, SRQs, polling, and event queries are an extremely powerful set of programming tools for assessing and controlling measurement systems.

### Queries Keep You Posted

Specific information about instrument settings, measurement modes, etc., can be obtained with various instrument query messages. All Tektronix ***Standard Codes and Formats*** queries take the form of a keyword followed by a question mark. You send the query to the instrument as a message, and the instrument answers the query by returning a message over the bus.

For example, here's a query sequence in 4041 BASIC statements to obtain the trigger setting of a 7D20 Programmable Digitizer:

```
INPUT #22 PROMPT "TRIG?":TRSET$
```

The statement starts by asking: "What are your trigger settings?" The instrument answers by getting the settings and putting them onto the bus as a message: TRSET$. The Input statement is the means of receiving the message and storing it in string variable TRSET$. When a string variable (variable name followed by $) is used with the Input statement, the entire message is stored in the variable.

Perhaps you are interested in all the control settings of an instrument. SET?, a universal query for all Tektronix ***Standard Codes and Formats*** instruments, causes the queried instrument to send a message that lists all of its current settings. This entire settings message can then be stored in a string variable. You can acquire and store a number of instrument configurations in different string variables. Then, just by sending the appropriate string variable to an instrument, the instrument can be reset at any time to any of the stored configurations. (Since the settings message can be several hundred characters long, it may be necessary with some software packages to extend or dimension the string variable to a length capable of holding the message.)

In essence, SET? is a "learn mode" of operation. It allows your software to "memorize" instrument setups for later use. If you would like to experiment with this, set your instrument to a familiar measurement configuration. Using 4041 BASIC, enter the following statements (20 is assumed here to be the address of a 7D20 Programmable Digitizer and SET$ is dimensioned to a length of 700 characters to be sure to accommodate all of the instrument's settings):

```
DIM SET$ TO 700
INPUT #20 PROMPT "SET?":SET$
```

Now change several of the control settings. Then enter the following statement:

```
PRINT #20:SET$
```

The instrument will switch its control settings back to those stored in SET$.

To see what is in SET$, just enter SET$. The entire settings message will be printed out on the terminal screen for your inspection.

Each Tektronix programmable instrument responds to a variety of queries, each query consisting of a keyword specific to the information desired. If you would like to know what measurement function your DM 5010 Programmable Digital Multimeter is set up for, just send it "FUNC?". The DM 5010 will prepare to send back DCV, OHMS, DIODE, ACV, or ACDCV and the measurement range the function is set for. Send the same query to your FG 5010 Programmable 20 MHz Function Generator, and it will prepare to send back FUNC SINE, FUNC SQUARE, OR FUNC TRIANGLE, depending on the waveform it is generating; another example of how Tektronix ***Standard Codes and Formats*** instruments work with you in plain English.

A significant added value in a Tektronix system is support—software, interfacing, training, service, and application support. Whatever your support needs, for individual programmable measurement instruments or for complete systems, we can help. And it's all available from one source—Tektronix.

## TEKTRONIX INSTRUMENTATION SOFTWARE LIBRARY

The Tektronix Instrumentation Software Library provides software and application information to aid in the planning, design, and implementation of measurement solutions using programmable measurement instruments and systems. Currently it contains three types of software—and more are planned.

### Measurement Software

Provides solutions to measurement problems using programmable measurement instruments or systems. Measurement Software is user-friendly and ready to run, requiring minimal software integration or modification. Measurement Software is provided only on media*[1].

### Instrument Utility Software

This is a set of subroutines and subprograms that perform common instrument functions. A single instrument/controller combination is addressed by each subroutine or subprogram. Instrument Utility Software is well documented and presented in a consistent format so it can be easily modified and integrated into application programs that you develop. Instrument Utility Software is provided only on media*[1].

### User-Exchange Software

Developed by users to perform specific measurements or functions with programmable measurement instruments or systems. User-Exchange Software is available either on media*[1] or as listings at no charge.

### The Tektronix Instrumentation Software Library Catalog

Contains abstracts and ordering information for available software. For a copy of the latest catalog, ask your Tektronix Sales Representative for Tektronix literature number 45W-5570.

*[1] *Contact your local Tektronix Sales Representative for complete ordering information and prices.*

## INTERFACING AND OPERATING SUPPORT

Tektronix provides documentation to help build and use your measurement system. Whether it's interfacing, programming, operation, or maintenance, you'll find what you need in documentation from Tektronix.

### Instrument Interfacing Guides

These serve as a system integration guide by aiding in instrument configuration, connection, and operation with a controller. Specific information on the GPIB operation of the instrument along with programming examples are provided. Designed to supplement the operator's manual, they are supplied free of charge with the instrument.

### Controller Programming Guides

Supplying an additional aid to GPIB system integration, these programming guides provide specific information and guidelines on a controller's GPIB operating capabilities, as well as suggestions for getting the best performance from your instrument/controller combination. Sample programs are used to demonstrate various aspects of GPIB operation and to show the processing power of the controller.

### Operator's and Service Manuals

A standard accessory with each Tektronix instrument and system, these documents provide complete and comprehensive information so you can operate and service your Tektronix measurement system.

## PROGRAMMABLE INSTRUMENTS NEWSLETTER

### *HANDSHAKE*

This applications newsletter is for signal processing and programmable instrument control. Published quarterly, it contains technical articles on measurement processes, techniques, and instruments. Subscriptions to *HANDSHAKE* are free upon request from your Tektronix Sales Representative.

## ONGOING SUPPORT

Tek's system support doesn't stop when you receive your programmable measurement instrument or system. Our support continues throughout it's lifetime through training, application assistance, software support, and service.

### Training

To help operators better understand their equipment and get the most out of their systems, training is available both at the home office and at selected sites around the world. In addition, in-depth service training is available for those companies who want to learn to service their own Tek equipment.

### Application Assistance

To help solve unique measurement problems our applications assistance is as near as your telephone. If your measurement needs are not answered by out standard software and documentation, Tektronix applications assistance is available in many areas of the U.S. and around the world to help design a solution just to fit your need.

### Software Support

To keep your software current and up-to-date, our software support is available at no charge during the warranty period. Post-warranty software support is available on a subscription basis.

### Service

For your programmable measurement instrument or system, service is available from Tektronix Service Centers at strategic locations throughout the world. You'll always receive expert assistance from some of the most highly trained and qualified personnel in the world.

For more information on any of the support available for Tektronix programmable measurement instruments or systems, contact your local Tektronix Sales Representative for details.

**A Controller to Match Your Instrumentation System Needs**

The one common element that binds both large and small instrumentation systems together is the system controller. Tektronix offers a number of IEEE Standard 488 Controllers to fit your system needs. The system, or instrument controller, is in reality just a computer that has been designed to optimize the interaction and communication between the controller and a wide variety of programmable instruments and peripherals. This interaction is enhanced by instrument control commands in a high-level programming language such as BASIC, eliminating the need for the user to understand the IEEE Standard 488 Interface protocol in detail. The user only needs to supply the instrument address and the function to be performed. The controller automatically takes care of the rest—interface handshaking, bus states and transitions, etc.

The ideal controller for a particular use depends upon the specific requirements of the application. Such varied applications as laboratory automation, manufacturing test, QA/QC, service/repair, and environmental data acquisition/analysis each have unique controller requirements. Some applications require little or no operator interaction and perform repetitive tasks over and over again. For these cases, a tamper-proof execute-only controller capable of running unattended with little or no display requirements is often very desirable.

The other end of the application spectrum may require a large amount of operator interaction for developing programs, providing operator prompts and instructions, reviewing intermediate or final test results, and making changes in the test setup based upon test results. Where graphics are helpful as an analysis tool, a controller with an integrated display screen may be the best choice.

Expandability and flexibility is another important consideration in choosing an instrument controller. For example, controllers without an integral CRT for display allow you to select the exact display features which best suit the requirements of the application. For program development, a low-cost alphanumeric-only terminal may be best. However, for interactive applications or data analysis and interpretation, a graphics terminal, perhaps with color, would be a better choice. This ability to choose screen size, resolution, number of lines, color, and other display parameters greatly enhances the controller's capability.

Likewise, the ability to add memory, program ROMs, system peripherals, etc., greatly enhances a system controller's capabilities. This expandability will allow you to reconfigure your system to meet future measurement needs as applications change.

Whatever your current or future instrumentation system needs, Tektronix controllers provide a choice to allow systems to be configured with the right operator interface, memory, display, hardware interfaces, and peripheral support.

GPIB IEEE-488

## 4041 System Controller

The 4041 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats*.

**Easy to Use Extended BASIC with Local/Global Variable Definition**

**32 Kbytes Memory Standard—Expandable to 512 Kbytes**

**Four ROM Packs Enhance the 4041 to allow PROM File Creation, Special Graphics, and Signal Processing**

**Easily Configured for Any IEEE Standard 488 Instrumentation**

**Execute Only Mode for Program Security**

**Detachable Keyboard (Option)**

**Modular Design—Rackmount or Portable**

**External Flexible and Hard Disk Supported Optionally**

The Tektronix 4041 System Controller is a powerful and flexible IEEE Standard 488 (GPIB) controller designed to work with Tektronix and other vendor's IEEE Standard 488 instrumentation. The standard configuration is intended principally for execute only environments such as production line testing. A variety of options and peripherals are available to equip the 4041 for more complete flexibility. Tektronix' full line of terminals (graphics or alphanumeric, storage or raster, and color) are completely compatible; to create an optimum programmer interface. Software features similarly span the range from the occasional programmer to the sophisticated programming team tackling the most complex applications.

**4041 Architecture**

The 4041 System Controller's main microprocessor is the powerful 16-bit 68000. A 20-character alphanumeric LED display; 20-character thermal printer; DC 100 Cartridge Drive; 18 key-numeric/function keypad; IEEE Standard 488 port; RS-232C port; and a real-time clock/calendar are all standard. An optional IEEE Standard 488/RS-232 port pair is available (Option 01) with the second IEEE Standard 488 port having DMA (Direct Memory Access) capability, allowing you to separate the slow instruments to one port and the fast instruments to the DMA port for optimum performance. Or a Mass Storage interface/RS-232 port pair are available (Option 03), for external disk mass storage to support interfacing to floppy and hard disks for greater file and data storage.

The 4041 BASIC language can be expanded by installing ROM (Read-Only Memory) packs to extend operational features of the 4041 into a broad range of systems applications.

Other options for system expansion include:

- An 8-bit parallel TTL port (Option 02)
- A Mass Storage Disk Interface/RS-232C port (Option 03)
- 160 Kbytes memory (Option 23)
- 256 Kbytes memory (Option 24)
- 512 Kbytes memory (Option 25)
- Program development ROMs and carrier (Option 30)
- Program development/debug keyboard (Option 31)

Option 30 and Option 31 enable a test engineer to easily and temporarily convert an execute-only 4041 into debug/edit mode, make necessary program changes, then restore it to the tamper-proof condition. Extensive program development, however, would normally be accomplished at a programming station consisting of an Option 30 plus an RS-232C terminal to permit multi-line viewing of program listings.

The 404I package is a compact unit of identical height and width to the Tektronix TM 5003 Power Module (for use with the TM 5000 product line). A 4041 and TM 5003 can be easily fastened together for use on the bench or rackmounted as a single unit. Rackmounted 4041/TM 5003 leads to extremely compact system configuration suitable for crowded benches or racks for use in vans, ships or aircraft.

### Language Enhancements

BASIC is an excellent language for controlling instrumentation applications, and was chosen for the 4041 System Controller. Its English-like commands, simple syntax, and line-by-line interpreter implementation combine for friendly, easy use. To improve the self-documenting characteristics and reduce maintenance costs, 4041 BASIC is enhanced by several features. Variable names may be up to eight characters, allowing the programmer to select meaningful names like Risetime, Voltage1, or Delay. 4041 BASIC includes FORTRAN-like subprograms; variable passing from main program to subprogram and the ability to declare any variable as local or global, means that a team of programmers can work quite independently on a massive task, with the main program ultimately being not much more than a series of subprogram Call statements. Other powerful features include optional data types (short and long floating point plus integer), a Proceed mode which allows I/O and processing operations to run independently for maximum system speed, logical unit assignment to define and characterize I/O oriented tasks and up to 512 kbytes of memory directly addressable (without extensive overlays or paging techniques).

### ROM Packs

The 4041R01 Graphics ROM pack gives the 4041 the ability to generate graphic commands to interact with peripheral devices using Tektronix compatible graphic codes. These high-level and primitive commands allow you to construct and incorporate graphic images, symbols, charts and diagrams into your system's application.

The 4041R02 Plotting ROM Pack gives the 4041 the capacity to generate graphs and to plot data with very little programming knowledge needed. It is designed as an easy-to-use tool to semi-automatically generate scientific graphics. The 4041R02 commands, given your data, draw axes with appropriate tic marks, scale and plot the desired data. The Plotting ROM pack requires the presence of the 4041R01 Graphics ROM Pack to operate.

The 4041R03 Signal Processing ROM Pack gives the 4041 the ability to support instrumentation system applications requiring waveform processing. Used with our programmable digitizers and oscilloscopes, this tool provides effective solutions for signal analysis. The 4041R03 commands provide a high-level approach to deal with signal processing applications—Fast Fourier Transforms (FFT), inverse FFT, Integration, Differentiation, Correlation and Convolution—normally solved by lengthy programming requiring extensive knowledge of waveform processing and computer fundamentals. Combined with the graphics and plotting ROM packs, the 4041R03 allows you to produce, analyze and display waveforms automatically.

The 4041R04 Utility ROM Pack adds still more general-purpose capabilities to your 4041 System Controller. These range from such convenience items as one-line descriptions of error codes to capabilities for building program files to store and read from the ROM drawer.

The 4041R04 Utility ROM Pack also has the ability to load "ROM" images from tape directly into 4041 memory. This allows the "ROMs" to become part of the 4041 BASIC language as though the routines were residing in the ROM drawer.

A Softload Routine called "BINARY" is currently available through the Tektronix Instrumentation Software Library (see page 323 for details and ordering information). "BINARY" routines add high-speed waveform acquisition of digitizer data, array segmenting, and a histogram routine.

### Test and Measurement Orientation

The 4041 System Controller was developed simultaneously with the TM 5000 modular instrument family, and is optimized as an instrument controller. Many of the IEEE Standard 488 functions are simple high level commands in 4041 BASIC. In its power-up default condition, the 4041 uses Tektronix *Standard Codes and Formats* and for easy communications with Tektronix IEEE Standard 488 instruments. Also, the 4041 has virtually complete control over all IEEE Standard 488 legal bus conditions. The 4041 uses Logical Unit assignment and stream specifications so that a particular device's format, syntax, end-of-message character, and other idiosyncrasies can be described one time in a Logical Unit assignment statement.

The error trapping and handling capabilities are of particular importance in test and measurement systems. Virtually any category of errors from instruments on the bus, peripherals, or even within the 4041 can be trapped and handled to maintain reliable system operation. The powerful self-diagnostics and error reporting features of Tektronix programmable instruments, along with the 4041's handling capabilities makes for an extremely efficient combination.

## CHARACTERISTICS

#### FRONT PANEL KEYBOARD

#### SYSTEM KEYS

**AUTO-LOAD** — Causes the internal magnetic tape to rewind and find the "AUTOLD" program. This program is then loaded into memory and execution begins.

**ABORT** — Halts program execution if no user-specified handler routine is called by the program. If a handler routine is specified for the ABORT key, program control is passed to that routine.

**PROCEED** — Performs one of the following functions depending on equipment or program state:

1. Causes program execution to start at the next program line if a Pause was encountered.

2. Resumes execution after an ABORT. If a program is loaded from the tape, execution starts from the first program line.

3. Delimits user input when requested from an Input statement.

**CLEAR** — Clears the alphanumeric display. Does not clear user-defined prompts or the input cursor from an INPUT statement.

**EEX** — Causes the number requested by an INPUT statement to be entered in scientific notation. Numbers entered after pressing the EEX (Enter Exponent) key are considered part of the exponent.

**PAUSE** — Halts the program after executing the current line. If the current program line is an INPUT statement, the program stops before the execution of INPUT.

#### USER-DEFINABLE FUNCTION KEYS

Numeric user-definable function keys, 0-9, can be assigned subroutines by the applications program. The keys may be redefined by the program during execution to allow for unlimited user routines. The function keys can be enabled or disabled under the control of a program.

Numeric values are assigned to these keys for entering information requested by an INPUT statement. When input has been completed, user functions assigned to these keys are re-enabled.

The other two keys on the front-panel keyboard are the decimal key (".") and the minus ("−") key. The decimal key is provided for decimal point entry associated with numeric and the minus key is used to enter negative numbers associated with numeric.

Keyboard overlays may be used for labeling the function keys with a number or an abbreviation of the user routines.

#### FRONT-PANEL DISPLAY

The front-panel display communicates test procedures and operator prompts and displays intermediate or final program results. The display is fully programmable.

#### ALPHANUMERIC DISPLAY

**Alphanumeric Line** — Twenty characters.

**LED** — Sixteen segments.

**Size** — Height: 3.8 mm (0.15 in). Width: 2.8 mm (0.11 in).

**Characters Per Cm** — 1.6 characters/cm (4 characters/in).

**Character Symbols** — Sixty-four.

**Message Viewing Time** — Programmable.

**Scrolling Rate** — Programmable.

#### SYSTEM INDICATORS

**LEDS** — Located on the display front panel indicate the status of the system.

**BUSY** — Indicates that a program is running. A blinking BUSY light indicates that the system has PAUSED (temporarily halted).

**POWER** — Indicates the machine is on.

**I/O** — Indicates that an Input/Output operation is being performed.

**FN** — Indicates that the user-definable function keys are enabled.

#### MAGNETIC TAPE DRIVE

Magnetic tape drive is used to store user's programs and data. The tape is the primary means of loading programs, particularly for execute-only applications; in addition, the tape drive provides for long-term unattended data logging.

**File Structure** — 48 named files (maximum).

**Capacity (Physical Records)** — 650 typical (600 minimum).

**Physical Record** — 256 bytes (typical tape capacity is 166,400 bytes).

**Average Transfer Rate** — 13,324 bits/s.

**Search Speed** — 1520 mm/s (60 in/s).

**Tape Rewind** — 1520 mm/s (60 in/s).

**Tape Cartridge** — 100A Certified Data Cartridge from Tektronix.

### PRINTER

The printer produces hard copies of the intermediate or final program results, operator prompts, and changes in variables or system status. Messages longer than 20 characters are printed on succeeding lines where the user can specify the appropriate indentation for better delineation and readability.

**Printing Method** — Thermal, fixed head.

**Capacity** — 20-character alphanumeric line.

**Font** — 5 x 7 dot matrix printed.

**Character Size** — 2.5 mm high x 1.8 mm wide (0.10 in high x 0.07 in wide).

**Line Spacing** — 4.23 mm (6 lines/in).

**Printing Speed** — 2.0 lines/s.

**Feed Speed** — 8.46 mm/s (0.34 in/s).

**Character Set** —
26 Uppercase letters
26 Lowercase letters
10 Numeric digits
34 Special characters
32 Control characters
128 Total

**Paper Size** — 60 mm x 25 m (2.36 in x 82 ft).

### CONTROLLING THE BUS

When using BASIC high level print and input commands, the 4041 automatically controls all bus management signals in the proper sequence for the desired interface task and instrument interaction. A bus management function program that uses direct IEEE Standard 488 mnemonic commands to accommodate differences in implementation of GPIB on other equipment. Virtually all legal bus states can be programmed this way, which affords a high degree of flexibility for addressing various system applications.

### BUS INTERRUPTS

The 4041 has the ability to detect and respond to various types of interrupt conditions that can be generated on the GPIB. User-specified software handlers can be written to perform various tasks when these conditions occur. Interrupts can be programmably ENABLED or DISABLED.

**Interrupt Conditions**

| Mnemonic | Message |
|---|---|
| SRQ | Service Request |
| EOI | End or Identify |
| IFC | Interface Clear |
| DCL | Device Clear |
| TCT | Take Control |
| MTA | My Talk Address |
| MLA | My Listen Address |

### BUS COMMUNICATION

Interface and bus device addressing are programmable. This allows the user to direct message and data flow to and/or from the appropriate interface and GPIB peripheral. Information such as primary and secondary addressing, along with pertinent device-dependent information, can be attached to a specific Logical Unit number. Subsequent communication with that GPIB device can be directed to the Logical Unit, eliminating the need for redundant or repetitious statement programming.

### TRANSFER RATES (IEEE STANDARD 488)

**Transfer Rates for the Standard Interface**

| | Input | Output |
|---|---|---|
| Normal Mode | Exceeds 5 kbytes/s | Exceeds 5 kbytes/s |
| Fast Mode | Exceeds 16.5 kbytes/s | Exceeds 19.5 kbytes/s |

### SERIAL INTERFACE

The 4041 comes with a standard serial asynchronous RS-232C interface. The 4041 can support applications requiring terminals, modem/host communication, or instrumentation with this interface protocol.

In addition to standard transmission rates from 75 to 9600 baud, transmission rates are programmable to any integer ranging from 2 to 9600 baud.

**Full Duplex** — Full capability (half duplex not supported).

**Transmit/Receive** — Matched rate only.

**Bits Per Character** — 5, 6, 7, or 8 bits.

**Stop Bits** — 1 or 2.

**Parity** — Even, Odd, High, Low, None.

### ERROR AND INTERRUPTS

Conditions such as parity, framing and overrun errors can all be programmably captured. User routines or handlers can then direct what action should be taken, depending on the particular condition.

The end of message delimiter (EOM) can be programmed to any one or two character ASCII string. This enables the 4041 to communicate with most hosts or peripherals via the serial interface.

### CLOCK/TIMER

One clock provides date and time of day which is programmably set. The timer clock returns the time in seconds since power up. The timer has 10 millisecond resolution.

### SELF-TEST

An integral part of the 4041 is the self-test feature, which assures the user of reliable operation. Self-test is executed automatically on power-up and performs extensive hardware and operating system tests.

### DYNAMIC RANGE

**Short Floating Point** — Maximum ±3.40282 E+38; Minimum ±2.93874 E−39.

**Long Floating Point** — Maximum ±1.7976931348623 E+308; Minimum ±5.562684646269 E−309.

**Integer** — −32768 to +32767.

**Character String Length (Maximum)** — 32767.

**Array Elements (Real, Integer or Character Arrays)** — 32767 elements maximum per row (or column); limited by total memory installed.

### AC POWER REQUIREMENTS

**Line Voltage** — 100 V ac to 120 V ac, 200 V ac to 240 V ac ±10%.

**Line Frequency** — 48 Hz to 66 Hz.

**Power Consumption** — 120 W (maximum).

### ENVIRONMENTAL CHARACTERISTICS

**Operating Temperature** — Without Data Cartridge or Printer Paper: 0°C to +55°C (+32°F to +131°F). With Data Cartridge or Printer Paper: 0°C to +45°C (+32°F to +113°F).

**Storage Temperature** — Without Data Cartridge or Printer Paper: −40°C to +75°C (−40°F to +167°F).

**Humidity** — Relative noncondensing 0°C to +45°C (+32°F to +113°F) −20% to 80% condensing.

**Altitude** — Operating: 4600 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

**EMC** — Meets FCC Part 15, Subpart J, Class A and VDE 0871 Class B.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 213 | 8.5 |
| Height | 180 | 7.2 |
| Depth | 520 | 20.8 |
| **Weights** | **kg** | **lb** |
| Net | 7.8 | 17.3 |
| Net (with options) | 8.7 | 19.3 |

### INCLUDED ACCESSORIES

Power cord (161-0066-00); blank overlays for FP keyboard (334-4074-00); system verification tape (062-5828-01); blank DC 100 Tape Cartridge (119-1350-00); RS-232 male loop back connector (013-0198-00); roll of printer paper (006-3557-00); Controller (GPIB) Programming Guide; instruction manual.

## ORDERING INFORMATION

**4041** System Controller ..... **$3,995**

**Option 01** — Second GPIB and RS-232C ports ..... **+$1,600**

**Option 02** — TTL Interface (8 Bit Parallel Interface) .. **+$800**

**Option 03** — Disk Interface and RS-232C port ..... **+$1,400**

**Option 23** — Added Memory 160 Kbyte Total ..... **+$700**

**Option 24** — Added Memory 256 Kbyte Total ..... **+$1,200**

**Option 25** — Added Memory 512 Kbyte Total ..... **+$2,200**

**Option 30** — Program Development ROMs and ROM Carrier ..... **+$995**

**Option 31** — Program Development Keyboard ..... **+$550**

### CONVERSION KITS

**Cabinet-to-Rackmount** — Equipped with slide-out assembly to rackmount a 4041 to the left of a TM 5003. Order 040-0984-01 ..... **$190**

**Cabinet-to-Rackmount** — Equipped with slide-out assembly to rackmount a 4041 to the right of a 7D20T. Order 040-1147-00 ..... **$200**

### ROM PACKS

**4041R01** — Graphics ROM Pack ..... **$495**
**4041R02** — Plotting ROM Pack ..... **$495**
**4041R03** — Signal Processing ROM Pack ..... **$795**
**4041R04** — Utility ROM Pack ..... **$295**
**Accessory Package Kit** — For use with 4041R04's PROM file system. Order 020-0102-00 ..... **$160**
**EPROM Kit** — For 4041R04. Order 020-0101-00 ..... **$60**

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

### FIELD INSTALLED MODIFICATIONS

**4041F01** — Same as Option 01 ..... **$1,800**
**4041F02** — Same as Option 02 ..... **$1,000**
**4041F03** — Same as Option 03 ..... **$1,600**
**4041F30** — Same as Option 30 ..... **$995**
**4041F31** — Same as Option 31 ..... **$550**
**040-1141-00** — Field upgrade, same as Option 23 ..... **$700**
**040-1142-00** — Field upgrade, same as Option 24 .... **$1,200**
**040-1143-00** — Field upgrade, same as Option 25 .... **$2,200**

**Note:** Contact your local Tektronix Sales Engineer before ordering field memory additions.

### OPTIONAL ACCESSORIES

**Blank ROM Carrier** -- Order 013-0215-00 ..... **$180**

# TEK SPS BASIC

Versatile Instrument Control

Powerful Signal Processing Operations

Full Graphics Capability

Flexible Peripheral Handling

Multi-Level Program and Instrument Tasking Control

Extensive Support and Documentation

**Tek SPS BASIC is a comprehensive, general purpose programming language with numerous enhancements for instrument control, waveform processing, peripheral handling, and graphic display.**

Modular in design, it provides an optimum balance between flexibility, programming efficiency and computing power; yet retains the easy-to-learn, easy-to-use, easy-to-remember characteristics of traditional BASIC. This makes it an ideal tool for beginners as well as expert programmers.

TEK SPS BASIC runs on any Tektronix CP1100 Instrument Controller or any DEC PDP-11 minicomputer. It consists of a resident monitor and an expandable library that lets you configure a software system to meet your unique measurement needs.

TEK SPS BASIC requires a minimum system consisting of a controller with two hard-disk drives or two flexible-disk drives, and a terminal.

### Versatile Instrument Control

- High-level GPIB driver for easy interaction with GPIB-compatible instruments.
- Low-level GPIB driver to permit line-level access to all IEEE Standard 488 features as well as custom-tailored instrument communications.
- Specialized drivers to control Tek's digitizing products.
- Specialized commands to process and log instrument data.
- BASIC extensions to let the user handle interrupts.

The high-level GPIB driver allows easier communication with Tektronix instruments. Information is sent in either ASCII or binary formats using simple commands. The driver does the line-toggling and address translation, enabling easy interaction with up to 14 instruments on each of (1 to 4) GPIB interfaces; 56 instruments maximum.

Though the high-level driver is not limited to Tektronix instruments, it can automatically translate codes and formats used by Tektronix to efficiently send data.

The low-level driver provides the capability to send and receive data one byte at a time, to toggle individual GPIB control lines, and to obtain detailed status information about the bus, the interface, or the instruments in the system. This driver gives fast, precise, complete GPIB control while saving controller memory space.

When an instrument chooses to use its asynchronous interrupt capability to send a signal to the controller, TEK SPS BASIC gives the user complete control over the response. Using the high-level GPIB driver, the user can simply direct program control to specific subroutines while the driver handles the GPIB housekeeping.

Plus, raw data transformation from Tek's digitizing instruments is done quickly and easily with specialized commands. Other commands permit fast logging and averaging of waveform data.

### Powerful Signal Processing

- Single-command array and waveform manipulation.
- Powerful mathematical transformations including Fourier analysis.
- String processing capability.

TEK SPS BASIC goes beyond what other programming languages offer in waveform processing convenience. A simple command, "get", accesses waveform array data from our digitizer, complete with sampling intervals, horizontal, and vertical scaling factors.

The waveform created can then be used in arithmetic expressions, and the scaling factors will be automatically updated to reflect the operations performed on the waveform.

The operations available for waveform arrays include standard arithmetic operators (+, −, ×, ÷) as well as the trigonometric, logarithm, and exponential functions. In addition, TEK SPS BASIC features array functions for providing minimum, maximum, RMS, size, and mean values, plus the time at which a waveform crosses a user specified threshold.

The package includes commonly used mathematical transformations such as integration, differentiation, Fast Fourier transforms (direct and inverse), convolution, and correlation. For a more detailed waveform analysis, subarray processing is also possible. With this capability, any specified portion of an array can be accessed with the same convenience as full arrays.

### Full Graphics Capability

- Single command waveform displays and X-Y plots.
- Seventeen commands for personalized graphics.
- Graphic input.
- Variety of Tektronix graphic peripherals

Usually, processing software stops where graphics begin. Once again, TEK SPS BASIC helps you significantly with its capability to generate comprehensive, easy to create graphic displays. A single command displays your waveforms with graticule and scale factors in conventional formats. You can also position your graph anywhere on the screen, select tic marks, and generate waveforms with selected symbols.

In addition, TEK SPS BASIC offers the capability of identifying a point on the screen which can then be transferred to your program.

Graphics are not restricted to waveform or array display. Point to point line drawings enable you to generate any kind of representation you may want; bar charts, pie charts, three dimensional functions.

Hard copy units are available for all Tektronix graphic terminals. See pages 65-68.

### Flexible Peripheral Handling

- Variety of compatible peripherals.
- Device independent communication protocol.
- Random and sequential access files.
- Direct access data-logging from instruments.
- File compatible with DEC RT-11 operating system.

TEK SPS BASIC communication is fast and easy, with a complete choice of peripherals including graphic and alphanumeric terminals, floppy disk, hard disks, cassette and magnetic tapes, paper tape reader and punch, and line printers. Its peripheral interfacing code is written to be device independent. Hardware can be updated without program modification.

Simple commands exist for creating, labeling, listing, modifying, copying, writing into or reading from files. Formats are selectable, so you can extend this compatibility to the hardware or software of you choice. Random-access files are also a standard feature of TEK SPS BASIC, allowing you to easily access selected portions of a file.

### Multilevel Program and Instrument Control

- Control of execution and scheduling of routines.
- Multitasking for error tracking.
- User-specified error-handling.
- Support for user-written BASIC drivers including interrupt processing.

TEK SPS BASIC offers numerous advanced features for those who need to push beyond the limits of conventional high-level language programming.

For instance, you have complete access to the mechanism used to decide which routines to execute. Organized into a "ready job" queue, a "current job" packet and a "suspended job" stack, this mechanism, "The Scheduler", makes sure that system resources are given to the most important routine ready to run at any given time.

BASIC commands permit you to enter routines into the "ready job" queue at a given time, after a given time, or on occurrence of a real-time event. Other commands or keywords allow you to assign a priority to each routine. Programming can be setup to automatically invoke control tasks, such as scans and self-check, while responding to asynchronous real-time events, such as instrument interrupts.

The Scheduler also stops all routines affected by a fatal error. You can control the impact of errors by linking together associated routines and assigning them a common task number.

Features normally accessible only through assembly-language level programming are offered by TEK SPS BASIC through the optional high-level support package. Memory addresses can be individually examined and changed; individual bits and bit patterns can be set, cleared, or tested; variables can be located in memory and manipulated at the bit level; values can be read or written in octal or hexadecimal as well as decimal representations. All these sophisticated operations are available in BASIC's "easy to learn, easy to use" format.

The high-level support package also offers an interrupt vector driver, which lets the programmer invoke special routines to handle instrument interrupts. This capability is particularly valuable in development of user-written instrument drivers.

In addition, BASIC offers many special commands and capabilities for custom-tailored programs. Using immediate mode commands new program lines can be entered during execution of a program. Typed input can be accepted and held until needed, or the keyboard can be "locked".

**For Ordering Information see the next page.**

**Software Maintenance**
Customers receive a periodic newsletter containing programming hints and responses to user questions. Many system errors can be corrected by customer-applied "patches." These short code sequences are published in the newsletter with instructions for adding them to established systems. Specific problems which appear to be possible software defects, may be addressed by submitting a Software Performance Report (SPR) which will be responded to in writing. (Category B support.)

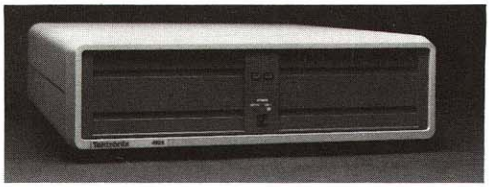
New packaged TEK SPS BASIC V03XM is configured for the DEC MICRO/PDP-11 and contains the following: Monitor, Signal Processing Module, Graphics Module, 7912AD Special Commands Module, 7612D Special Commands Module, GPIB High Level Driver Module, new disk driver, and line printer driver.

**ORDERING INFORMATION**
**SOFTWARE PACKAGES**

**CP57000** TEK SPS BASIC (Monitor) . **$2,190**
**CP57001***1 Signal Processing ..... **$950**
**CP57002***1 Graphics ..... **$700**
**CP57003** R7912 Transient Digitizer Driver ..... **$950**
**CP57004** Digitizing Oscilloscope (DPO) Driver ..... **$500**
**CP57005** DPO Envelope Command ..... **$350**
**CP57006***1 7912AD Special Commands Driver ..... **$650**
**CP57007***1 High Level Support ..... **$350**
**CP57008** Assembly Level Support ..... **$1,000**
**CP57009***1 GPIB High Level Driver ..... **$500**
**CP57010***1 7612D Special Commands . **$300**
**CP57500***1 Extended Memory (V02XM) TEK SPS BASIC (Monitor) ..... **$3,190**
**CP575XX***1 Extended Memory Software (V02XM) are priced the same as V02 modules above, except for CP57500.
**CP58000** (V03XM) TEK SPS BASIC Software for MICRO/PDP-11 ..... **$4,000**

**1 Indicate modules included in V03XM CP58000.*

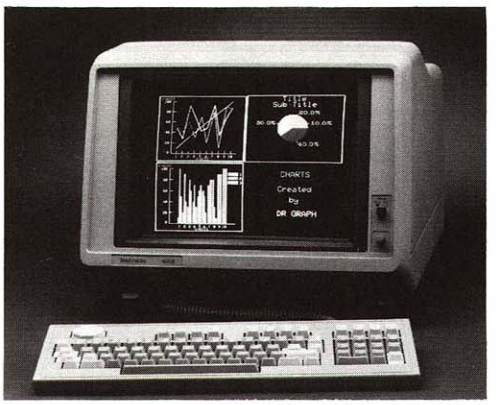
**For additional information or a demonstration of the TEK SPS BASIC software family, call the Tektronix Sales Office in your area and ask for your Sales Engineer.**



## 4926 10 Megabyte Hard Disk

- 5 1/4-Inch Half-Height Drives
- Easy Integration Through a Standard Interface
- Complements 4110 Series Terminals with Local Programmability
- 5 1/4-Inch Winchester Technology
- 10 Megabyte Formatted Capacity

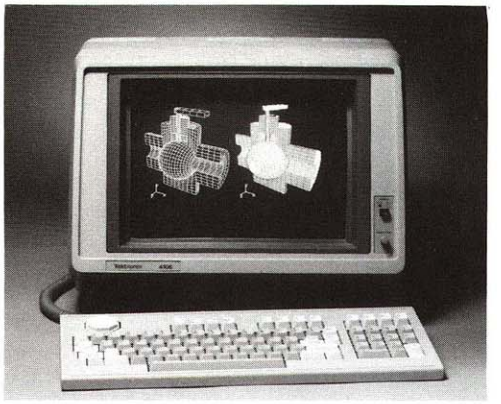
See page 69.



## 4105 Computer Display Terminal

- 8 Kbytes Segment Memory
- Low-Cost, High-Performance Color Graphics and Alphanumerics
- Supported by Color Copiers, Color Graphics Rasterizer, and Local Graphics Processing Module
- Compatible with Tek 4010, 4100, and 4110 Series Terminals
- Operates in IBM SNA Environments with the 4970 Cluster Controller

See page 55.



## 4106 Computer Display Terminal

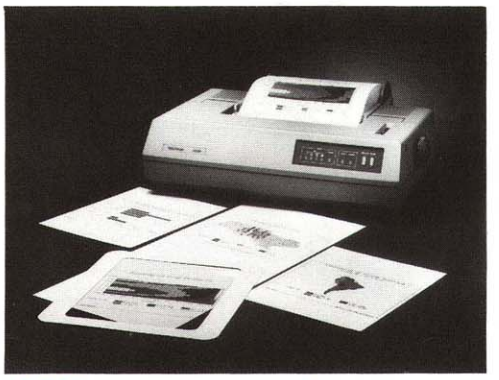
- 9 Kbytes Segment Memory
- Low-Cost, High-Performance Color Graphics and Alphanumerics
- Supported by Color Copiers, Color Graphics Rasterizer, and Local Graphics Processing Module
- Compatible with Tek 4010, 4100, and 4110 Series Terminals
- Operates in IBM SNA Environments with the 4970 Cluster Controller

See page 56.

## 4107 Computer Display Terminal

- 128 Kbytes Segment Memory
- Low-Cost, High-Performance Color Graphics and Alphanumerics
- Supported by Color Copiers, Color Graphics Rasterizer, and Local Graphics Processing Module
- Compatible with Tek 4010, 4100, and 4110 Series Terminals
- Operates in IBM SNA Environments with the 4970 Cluster Controller

See page 57.



## 4695 Color Graphics Copier

- Unprecedented Image Quality in its Price Range
- Clear Transparency Capability
- Quiet, 20 Character/Second Printing
- Small, Compact Package
- Choice of Roll or Sheet Paper

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## IEEE STANDARD 488 COMPATIBLE

Especially designed for precise automatic waveform measurements in demanding applications in R&D and production environments.

### DIGITAL OSCILLOSCOPES AND WAVEFORM DIGITIZERS

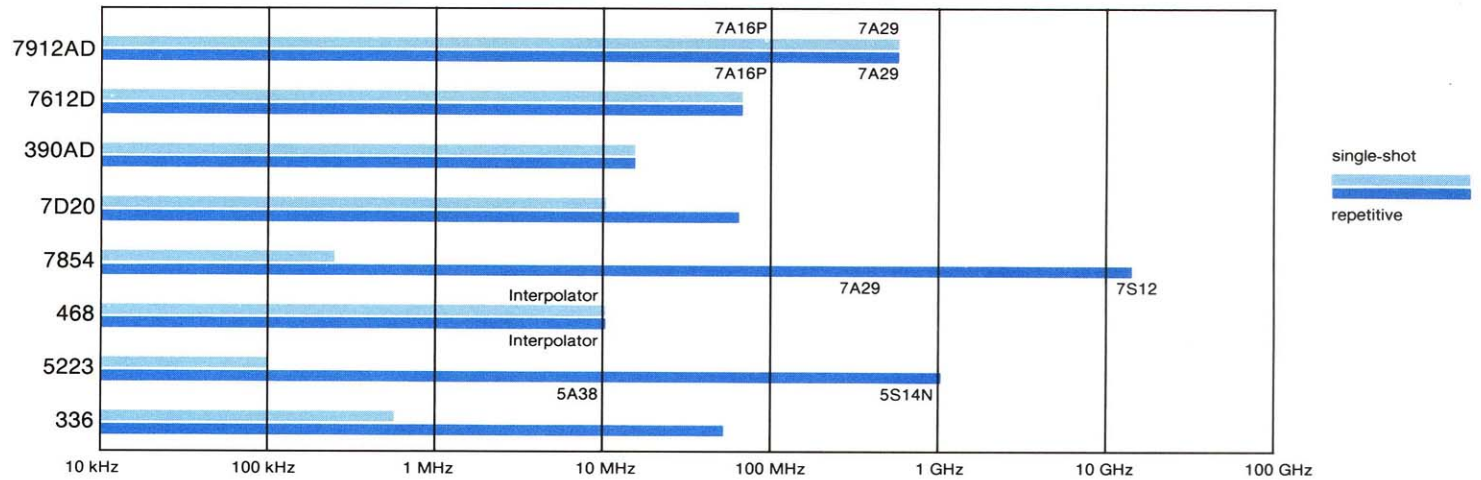
| Type | Analog Digitizing BW | Maximum Digitizing Rate | Vertical Resolution | Data Words Per Waveform | Maximum Stored Waveforms | Useful*1 Storage BW (SS) | Equiv*2 Storage BW (rep) |
|---|---|---|---|---|---|---|---|
| 390AD | 15 MHz | 30 MHz dual channel<br>60 MHz CH 1 | 10 Bits | 2048 dual channel<br>4096 CH 1 only | 2 | 15 MHz | 15 MHz |
| 336 | 50 MHz | 1 MHz | 8 Bits | 1024 each channel | 2 (16 with Option) | 140 kHz | 50 MHz |
| 7854 | 400 MHz*3 | 500 kHz Ext Clock | 10 Bits | Up to 1024 | Up to 40 | 50 kHz | 400 MHz |
| 468 | 100 MHz | 25 MHz | 8 Bits | 512 in Alt<br>256 in chop | 4 | 10 MHz | — |
| 5223 | 10 MHz | 1 MHz | 10 Bits | 1016/plug-in | 2 to 4 | 100 kHz | 10 MHz |
| 7912AD | 500 MHz | 100 GHz | 9 Bits | 512 | 1 | 500 MHz | 500 MHz |
| 7612D | 80 MHz | 200 MHz | 8 Bits | Up to 2048 | 2 to 16 | 80 MHz | 80 MHz |
| 7D20/<br>7D20T | 70 MHz | 40 MHz | 8 Bits | Up to 1024 | 6 | 10 MHz | 70 MHz |

*1 *Useful Storage Bandwidth is a measure of the highest frequency sinewave that can be stored in a single sweep and displayed in a visually useful manner. This is dependent on both the maximum digitizing rate as well as the display reconstruction technique used.*

*2 *Equivalent Storage Bandwidth indicates the highest frequency repetitive signal that can be stored and displayed with less than 3 dB loss of signal amplitude using equivalent time digitizing techniques.*

*3 *14 GHz with sampling.*

### WAVEFORM ACQUISITION CAPABILITY




This section brings together high performance digitizing mainframes, stand-alone digitizers and portable digital storage oscilloscopes suited to today's demanding measurement needs.

The high performance digitizing mainframes offer a wide choice of performance capabilities. Depending on the mainframe, capture high or low speed signals that are repetitive or single shot. Configure mainframes to your individual needs from a choice of a score of plug-ins. The 7854 combines outstanding analog and digital performance with microprocessor-based waveform processing whereas the 7612D and 7912AD combine outstanding analog and digital performance with full programmability. The 7D20T incorporates a 7D20 into its own power module but without a display. The 7D20T is the ideal high performance digitizer in automated systems applications where visual display of the acquired signals is not required.

Adjunct to the 7000 Series digitizing mainframes is the SONY/TEKTRONIX 390AD which features dual-channel and dual-time-base operation.

The 336 displays both analog and digitized waveforms simultaneously and can store up to 16 digitized waveforms for recall and display. It is microprocessor controlled and incorporates alphanumeric CRT readouts of the scale factors and cursor positions.

The 5223 Digitizing Oscilloscope is capable of displaying real time and stored waveforms simultaneously. The 5223 accesses the digital storage functions by using the 5B25N Time Base.

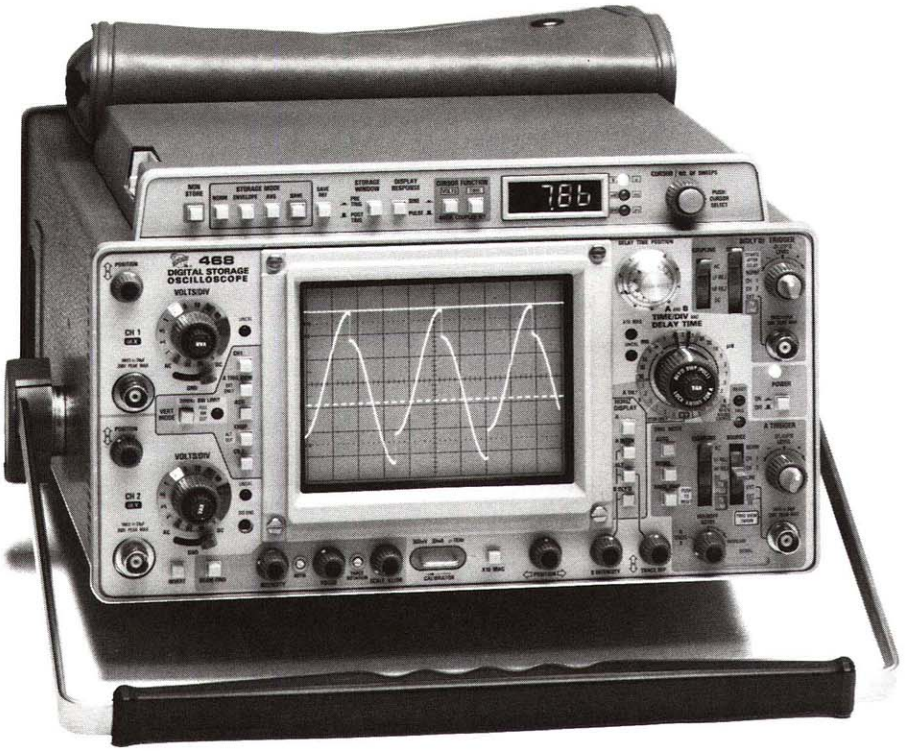
The high performance 468 Portable Oscilloscope has unlimited storage time; expandable, repositionable stored traces; Save Reference memory; pretrigger viewing; and correction for the trigger uncertainty. These factors, inherent in digital storage, make the 468 the most versatile digital storage scope available.

### Digital Storage

Digital storage requires digitizing and reconstruction processes. "Digitizing" consists of "sampling" and "quantizing." Sampling is the process of obtaining the value of an input signal at discrete points in time; quantizing is the transformation of that value into a binary number by the analog-to-digital converter (ADC) in the digital scope. You determine how often digitizing occurs by the time base. The time base uses a digital clock to time the analog-to-digital (A/D) conversion and to store the data in memory. The rate at which this happens is the digitizing rate (or sampling rate).

Once the data is in the digital memory, it can be read out and reconstructed for displaying or further waveform processing.

# TEK 100 MHz DUAL TRACE DIGITAL STORAGE OSCILLOSCOPE




GPIB IEEE-488

## 468/R468

The 468 and R468 with Option 02 comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

**10 MHz Useful Storage Bandwidth**

**Cursors for Time and Voltage Measurements**

**Signal Averaging**

**Envelope Mode (Patented)**

**GPIB Option**

**100 MHz Nonstorage Bandwidth**

Advancing the state-of-the-art in digital storage oscilloscopes is the Tektronix 468. This high performance portable scope is capable of accurately storing and displaying 10 MHz single shot events using a unique display interpolation system.

The 468 was designed with many features which enhance its usefulness in your applications. Cursors and a calibrated LED readout enable you to measure time or voltage differences easily and accurately.

Signal Averaging, now standard on the 468, can be used to remove random noise from a signal and improve measurement accuracy.

The Envelope mode, (patented), uses multiple sampling rates and digital memory to capture and record the maximum and minimum excursions of a waveform. The resulting waveform "envelope" can be used to catch glitches, view frequency drift and amplitude modulation, or detect aliasing. Unlimited storage time, expandable, repositionable stored traces; Save Reference memory; pretrigger viewing; and correction for the trigger uncertainty inherent in digital storage make the 468 the most versatile digital storage scope available today.

Option 02 provides a GPIB interface (talk only). This transmits stored waveforms and scale factor information to a listener or controller.

Other options include a TV sync separator, EMC shielding, X-Y recorder output.

## CHARACTERISTICS

### DIGITIZER, MEMORY

**Speed** — Digitizing rates from 10 samples/s at 5 s/div to 25 mega-samples/s at 2 μs/div and faster. Digitizing rate changes proportionate to sweep speed (50 data words/horizontal div). Chopped mode effectively halves the digitizing rate/waveform.

**Resolution** — Eight bit (one part in 256) vertical resolution.

**Memory Size** — Up to two 512-word waveforms or four 256-word waveforms can be stored and displayed.

**Interpolator** — Two firmware interpolators; one optimized for sine waveforms, one optimized for pulse waveforms.

### VERTICAL DEFLECTION (2 IDENTICAL CHANNELS)

**Bandwidth and Risetime*1**

**Storage Modes*2**

| Display Response | Bandwidth | Risetime |
|---|---|---|
| Sine | 10 MHz | NA |
| Pulse | 3.5 MHz | 64 ns |

**Nonstore Modes*3**

| Temperature Range | Bandwidth | Risetime |
|---|---|---|
| −15°C to +40°C | dc to 100 MHz | 3.5 ns |
| +45°C to +55°C | 85 MHz | 4.1 ns |

**1 At all deflection factors from 50 Ω terminated source.*

**2 Bandwidth measured at 5% envelope error and maximum sampling rate, using appropriate interpolator. Risetime is 1.6 times minimum sample interval. Chopped mode halves the bandwidth.*

**3 Measured at −3 dB. Bandwidth may be limited to ≈20 MHz by bandwidth limit switch.*

Cascaded bandwidth is at least 50 MHz when signal out is terminated in 50 Ω.

Lower −3 dB point. Ac Coupling 1X Probe: 10 Hz or less. 10X Probe: 1 Hz or less.

**Deflection Factor at Bandwidth** — Storage Modes: 0.5 mV/div to 5 V/div. Nonstore Modes: 5 mV/div to 5 V/div. 1-2-5 sequence, accuracy is ±3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div. In cascade mode sensitivity is ≈1 mV/div. Stored images can be expanded by factor of 10 vertically.

**Display Modes** — CH 1; CH 2 Add (normal and inverted), Trigger View (nonstore only). Alternate, Chopped: ≈250 kHz rate, in any combination electronically switched in nonstore; in storage chop rate is ½ the digitizing rate.

**Envelope Mode** — Records waveform envelope over multiple sweeps. 5 MHz digitizing rate from 5 s/div to 10 μs/div; 10 MHz digitizing at 5 μs/div; 25 MHz digitizing from 2 μs/div and faster. Number of sweeps equals 1 to 256 plus continuous setting.

**Signal Averaging** — 2 to 256 sweeps can be averaged together to remove random noise.

**Common-Mode Rejection Ratio** — At least 20 dB at 20 MHz (10 MHz in storage) for common-mode signals of 6 div or less.

**Automatic Scale Factor** — Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two readout lights behind the knob skirts. All LEDs are off when the channel is not displayed.

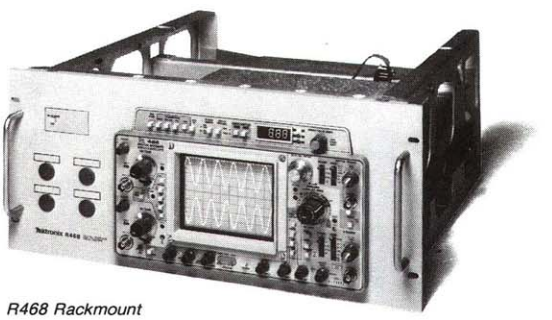
**Ground Reference Display** — In storage modes moving the coupling selector to ground position will locate ground and display a reference dot at left edge of CRT.

**Input R and C** — 1 MΩ ±2% paralleled by ≈20 pF.

**Maximum Input Voltage**

| | |
|---|---|
| Dc coupled | 250 V (dc + peak ac)<br>500 V (p-p ac at 1 kHz or less) |
| Ac coupled | 250 V (dc + peak ac)<br>500 V (p-p ac at 1 kHz or less) |

**Delay Line** — Permits viewing leading edge of displayed waveform.



*R468 Rackmount*

### HORIZONTAL DEFLECTION

**Time Base A** — 0.02 μs/div to 5.0 s/div (0.5 s/div in nonstore mode) in a 1-2-5 sequence. X10 magnifier extends maximum sweep rate to 2 ns/div.

**Time Base B** — 0.02 μs/div to 5.0 s/div (50 ms/div in nonstore mode) in a 1-2-5 sequence. X10 magnifier extends maximum sweep rate to 2 ns/div.

**Variable Time Control** — In storage modes has no effect. In nonstore mode Time Base A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div LED warning light indicates uncalibrated setting.

**Time Base Accuracy** — Full 10 cm Storage Modes 0.1%.

**Nonstorage Mode**

| | +20°C to +30°C | −15°C to +55°C |
|---|---|---|
| Unmagnified | ±2% | ±3% |
| Magnified | ±3% | ±4% |

**Horizontal Display Modes**

Storage: A, B delayed.

Nonstorage: A, A intensified, alternate, B delayed. B ends A for increased intensity in the delayed mode. Electronic switching between intensified and delayed sweep. A sweep and B sweep may be viewed simultaneously.

### CALIBRATED SWEEP DELAY

**Delay Time Range** — 0.2 to X10 delay time/div settings of 200 ns to 0.5 s.

**Differential Time Measurement Accuracy**

| Delay Time Setting | +15°C to +35°C |
|---|---|
| Over one or more major dial div | ±1% |
| <1 major dial div ± 0.01 major dial div | |

**Jitter** — One part or less in 50,000 (0.002%) of 10X the A sweep time/div setting. One part in 20,000 (0.005%) when operating from 50 Hz line.

### TRIGGERING A AND B

**A Trigger Modes** — Normal (sweep runs when triggered). Automatic (sweep runs in the absence of a triggering signal and for signals below 30 Hz). Single Sweep (sweep runs one time on the first triggering event after the reset selector is pressed). LED lights indicate when sweep is triggered and when single sweep is ready.

**A Trigger Holdoff (Nonstore Only)** — Adjustable control permits a stable presentation of repetitive complex waveforms.

**B Trigger Modes** — B runs after delay time (starts automatically at the end of the delay time) and B triggerable after delay time (runs when triggered). The B delayed sweep runs once, in each of these modes, following the A sweep delay time.

**Storage Trigger Positions** — Posttrigger Point: 1.25 div. Pretrigger: 8.75 div.

**Time Base A and B Trigger Sensitivity and Coupling**

| Coupling | To 25 MHz | At 100 MHz |
|---|---|---|
| Dc Internal | 0.3 div deflection | 1.5 div deflection |
| Dc External | 50 mV | 150 mV |
| Dc External ÷ 10 | 500 mV | 1.5 V |
| Ac | Requirements increase below 60 Hz | |
| Ac LF Reject | Requirements increase below 50 kHz | |
| Ac HF Reject | Requirements increase below 60 Hz and above 50 kHz | |

**Digital Storage Jitter** — 0.5 ns or less at 100 MHz and 2 ns/div.

**Digital Trigger Uncertainty** — Correction circuit for the ±½ sample interval trigger uncertainty that is caused by asynchronous trigger/sample clock relationship.

**A Trigger View (Nonstore Mode Only)** — Electronically switched trigger view displays the external signal used for A sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal which can be displayed simultaneously. The deflection factor is ≈100 mV/div (1 V/div with external ÷10).

**Level and Slope** — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. External: Through at least ±2 V. External ÷10: Through at least ±20 V.

**A Sources** — Normal, CH 1, CH 2, Line, Ext, and Ext ÷10.

**B Sources** — Starts after delay, Normal, CH 1, CH 2, and External.

**External Inputs** — R and C ≈1 MΩ paralleled by ≈20 pF. 250 V (dc + peak ac) maximum input.

### X-Y OPERATION

**Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical)** — 5 mV/div to 5 V/div, accuracy is ±4%. Bandwidth is dc to at least 4 MHz. Phase difference between amplifiers is 3° or less from dc to 50 kHz. Nonstore mode only.

### DISPLAY

**CRT** — 8 x 10 cm display. Horizontal and vertical centerlines further marked in 0.2 cm increments. GH (P31) Phosphor standard; BE (P11) optional. 18 kV accelerating potential.

**Graticule** — Internal, nonparallax; variable edge lighting; markings for measurement of risetime.

**Beam Finder** — Compresses trace to within graticule area for ease in determining the location of an offscreen signal. A preset intensity level provides a constant brightness.

**Z-Axis Input** — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 50 MHz. Nonstore mode only.

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C. Filtered forced air ventilation is provided.

**Altitude** — Operating: To 4600 m (15,000 ft). Maximum allowable ambient temperature decreased by 1°C/1000 ft from 5,000 to 15,000 ft. Nonoperating: To 15 000 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (four g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in one minute cycles.

**Humidity** — Operating and Nonoperating: Five cycles (120 hours) to 95% relative humidity as specified in MIL-T-28800B (par 3.9.2.2).

**Shock** — Operating and Nonoperating: 30 g's ½ sine, 11 ms duration, three shocks/axis in each direction for a total of 18 shocks.

### OTHER CHARACTERISTICS

**Amplitude Calibrator**

| | | |
|---|---|---|
| Output Voltage | 0.3 V | 1% 0°C to +40°C |
| Output Current | 30 mA | 2% +20°C to +30°C |
| Frequency | ≈ 1 kHz | |

**Vertical Signal Output** — CH 1 vertical signal is dc to at least 50 MHz (−3 dB) and ≈25 mV/div terminated into 50 Ω, and ≈50 mV/div terminated into 1 MΩ.

**Gate Outputs** — Positive gates from both time bases (≈5 V).

**Power Requirements** — Quick change line voltage selector provides four ranges to cover 90 V to 132 V and 198 V to 250 V. 48 Hz to 440 Hz, 150 W maximum at 115 V and 60 Hz.

### PHYSICAL CHARACTERISTICS

| Dimensions (468) | mm | in |
|---|---|---|
| Width (with handle) | 328 | 12.9 |
| Height (with feet & pouch) | 191 | 7.5 |
| Depth (with panel cover) | 550 | 21.7 |
| Depth (handle extended) | 600 | 23.6 |
| **Weights ≈ (468)** | **kg** | **lb** |
| Net (without panel cover) | 13.6 | 30.0 |
| Net (with panel cover and accessories) | 15.0 | 33.0 |
| Shipping | 21.7 | 47.0 |
| **Dimensions (R468)** | **mm** | **in** |
| Width | 483 | 19.0 |
| Height | 223 | 8.8 |
| Depth | 553 | 21.8 |
| **Weights** | **kg** | **lb** |
| Net | 18.6 | 41.0 |
| Shipping | 25.5 | 56.0 |

### INCLUDED ACCESSORIES

Two P6105 10X probes (010-6105-03), blue accessory pouch (016-0594-00), clear pouch (016-0537-00), blue CRT light filter (337-1674-00), clear CRT light filter (337-1674-01), ground wire (134-0016-01), two 1½-amp fuses (159-0016-00), one ¾-amp fuse (159-0042-00); instruction manual.

## ORDERING INFORMATION

**468** Storage Oscilloscope ..... **$6,500**

**R468** Rackmount Storage Oscilloscope ..... **$6,805**

### INSTRUMENT OPTIONS

**Option 02** — For 468. GPIB Interface follows Tektronix *Standard Codes and Formats* ..... **+$860**

**Option 02** — For R468. GPIB Interface follows Tektronix *Standard Codes and Formats* ..... **+$905**

**Option 04** — EMC Environmental ..... **+$200**

**Option 05** — TV Sync Separator (Provides triggering on TV field and line) ..... **+$350**

**Option 11** — For 468. X-Y Recorder Output (Not compatible with Option 02) ..... **+$525**

**Option 11** — For R468. X-Y Recorder Output (Not compatible with Option 02) ..... **+$550**

Modificatlon kits, for field conversion of existing 468s to Option 02, are available. These typically cost more than when the option is ordered with the instrument. Contact your Tektronix Sales Engineer, Distributor, or Representative for information.

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

### OPTIONAL ACCESSORIES

**Service ROM** — This provides service and signature analysis routines for verification and troubleshooting the digital portion of the instrument. Recommended to be used with a Tektronix 308 Data Analyzer. Order 067-0989-00 ..... **$85**

**Probes** — See page 436 for complete probe selection.

| Probe Type | Attenuation | Input Impedance | Bandwidth*1 |
|---|---|---|---|
| P6063B 6 ft | 1X | 1 MΩ 105 pF | 6 MHz |
| | Switchable | | |
| | 10X | 10 MΩ 14pF | 90 MHz |
| P6202A 2 m FET Probe | 10X | 10 MΩ 2 pF | 100 MHz |
| | 100X Head | 10 MΩ 2 pF | 100 MHz |
| | Ac Head | 10 MΩ 4 pF | 100 MHz |
| **Current Probe** | **Calibration** | **Insertion Impedance** | |
| P6022 5 ft | 1 mA/mV | 0.03 Ω at 1 MHz | 85 MHz |
| | 10 mA/mV | Increasing to | |
| | (Selectable) | 0.2 Ω @ 120 MHz | |

**1 Nonstore modes — Bandwidths are measured at the upper −3 dB and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.*

**Folding Polarized Viewing Hood** — Order 016-0180-00 **$40**

**Collapsible Viewing Hood** — Binocular. Order 016-0566-00 ..... **$15**

**Protective Cover** — Waterproof, blue vinyl. Order 016-0365-00 ..... **$21**

**Mesh Filter** — Improves contrast and EMC filtering. Order 378-0726-01 ..... **$55**

**Portable Instrument Cart** — Order K212 ..... **$330**
Refer to page 429 for complete description.

**Instrument Shuttle** — Order K117 ..... **$265**
Refer to page 429 for complete description.

**1105 Battery Power Supply** ..... **$1,550**

**Rack Adaptor** Order 016-0675-00 ..... **$350**

### RECOMMENDED CAMERA

**C-30BP Option 01** — General Purpose Compact Camera Includes 016-0301-00 mounting adaptor/corrector lens. Order C-30BP Option 01 ..... **$1,489**

**For further information see camera section.**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect (503) 627-9000, Ext 99.**

# SONY®/TEKTRONIX® 50 MHz DUAL TRACE DIGITAL STORAGE OSCILLOSCOPE

## GPIB IEEE-488 336

The 336 with Option 01 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**1 MS/s, 140 kHz Useful Storage Bandwidth**

**Cursors for Time and Voltage Measurements**

**Signal Averaging**

**Envelope Mode**

**GPIB and 8 Screen Memory Option (16 k)**

**50 MHz Nonstorage Bandwidth**

**CRT Readout**

The SONY/TEKTRONIX 336 is a combination nonstorage and digital storage portable oscilloscope. It is capable of displaying analog and digitized waveforms simultaneously, and can store up to 18 digitized waveforms for recall and display. The 336 is a microprocessor controlled instrument that incorporates alphanumeric CRT readouts of the vertical and horizontal scale factors, the delay time position, and voltage and time readouts of the cursor positions. Many of the oscilloscope features and modes are chosen from a menu displayed on the CRT rather than from hard-wired front-panel switches. Also included is an Auto mode for both vertical volts per division and horizontal time per division, allowing "hands off" operation in many applications.

The 336 has a dual-channel, dc-to-50 MHz vertical deflection system for both nonstorage and equivalent-time digitizing. Storage bandwidth for single sweep events (waveforms acquired as the result of a single triggering event) is dc-to-140 kHz. The vertical channels have calibrated deflection factors from 5 mV to 10 V per division with a choice of either ac or dc input coupling. In the Nonstore mode, the 336 operates like a conventional oscilloscope.

GPIB (talker only) is optional on the 336. Included in the option is a memory backup of up to eight screens (two 1 k waveforms each) of information.

## CHARACTERISTICS

### DIGITIZER AND MEMORY

**Speed** — Digitizing rates up to 1 mega-sample/s.
**Useful Storage Bandwidth** — Real Time Sampling: Dc to 140 kHz (−3 dB). Equivalent Time Sampling: Dc to 50 MHz (−3 dB).
**Resolution** — Vertical: Eight bit. Horizontal: Ten bit.
**Memory Size** — Standard: 2 kbyte (one frame of two waveforms). Option 01: 16 kbyte (up to eight frames of two 1 k waveforms each storage capacity). Data Retention: At least 3 days (after 8 hrs of operation).

### VIEW DISPLAY MODE

This is the saved "store" waveform (saved from Store display mode). Process functions are the same as Store display mode.

### NONSTORED AND STORED DISPLAY MODES

The following characteristics apply to both modes unless otherwise indicated.

### VERTICAL DEFLECTION (2 IDENTICAL CHANNELS)

**Bandwidth and Risetime*[1]**

| 0°C to +40°C | +40°C to +55°C |
|---|---|
| Dc to at least 50 MHz | Dc to at least 40 MHz |

*[1] At all deflection factors from a 50 Ω source.*

**Deflection Factor** — Range: 5 mV/div to 10 V/div. Accuracy is ±3%. Uncalibrated, continuously variable between steps, and to at least 25 V/div.
**Vertical Modes** — Stored Mode: CH 1, CH 2, Chop, Dual and Trigger View. Nonstored Mode: CH 1, CH 2, Chop and Dual.
**Normal Mode (Store Mode Only)** — Acquired displayed signal.
**Envelope Mode (Store Mode Only)** — 1, 8, 16, 32, 64, 128, 256 sweeps, or continuous at s/div settings of 2 ms/div to 0.2 s/div.
**Average Mode (Store Mode Only)** — 8, 16, 32, 64, 128 or 256 sweep averages.
**Process Mode (Store and View Mode Only)** — Waveform: CH 1 + CH 2 is within 6%. CH 1 − CH 2 is within 6%. CH 1 × CH 2 is within 7%. Parameters (Selectable): RMS is within 3% + 6% of V/div setting. Mean is within 3% + 4% of V/div setting. P-p is within 3% + 4% of V/div setting. Store or view waveforms must acquire inital ground reference level.
**Common-Mode Rejection Ratio** — At least 10:1 at 10 MHz (5 MHz storage).
**Input R and C** — 1 MΩ ±2% paralleled by 33 pF.

### HORIZONTAL DEFLECTION (NONSTORE MODE ONLY)

**Time Base A** — 0.2 s/div to 0.1 μs/div in a 1-2-5 sequence. X10 MAG extends the maximum sweep rate to 10 ns/div. (At sweep speeds slower than 0.2 s the scope automatically goes to Roll mode.)
**Time Base B** — 50 ms/div to 0.1 μs/div in a 1-2-5 sequence. X10 MAG extends the maximum sweep rate to 10 ns/div.
**Variable Time Control** — Continuously variable between calibrated settings of the A s/div switch. Extends the slowest sweep rate to at least 0.5 s/div.
**Time Base Accuracy**

| | +20°C to +30°C | 0°C to +55°C |
|---|---|---|
| Unmagnified | ±2% | ±3% |
| Magnified | ±3% | ±4% |

### DIGITAL STORAGE HORIZONTAL ACQUISITION

**Resolution** — Ten bit. 1024 data points.
**Range** — Equivalent Time Sampling: 50 ns/div to 0.1 ms/div. Single Sweep Storage: 0.2 s/div to 0.1 ms/div. Roll Mode: 20 s/div to 0.5 s/div. Envelope Mode: 0.2 s/div to 2 ms/div.
**Accuracy** — 3% from +20°C to +30°C; 4% from 0°C to +55°C.
**Horizontal Display Modes** — Nonstore: A sweep, B delay, alternate, X-Y. Storage: A sweep, B delay, X-Y.

### CALIBRATED SWEEP DELAY

**Differential Time Measurement Accuracy (Nonstore Mode)**

| +15°C to +35°C | within 1% of indicated value |
|---|---|
| 0°C to +55°C | within 2.5% of indicated value |

**Delay Time Jitter (Nonstore Mode)** — ≤1 part in 10,000.
**Delay Time Resolution (Store Mode)** — 14 bit.
**Cursor Accuracy (Store Mode)** — ΔV: Within 3%. ΔT: Real time sampling is ±0.1% of full scale. Equivalent time sampling from +20°C to +30°C is ±3%; from 0°C to +55°C is ±4%.

### TRIGGERING A AND B

**A Trigger Modes** — Normal: Sweep generator requires a trigger to generate a sweep. Automatic: Sweep generator free runs in the absence of a trigger. Single sweep: One sweep is initiated by the first trigger after reset.
**Trigger Sources** — Internal, CH 1, CH 2, composite or external.
**Sensitivity and Coupling**

| Coupling | To 10 MHz | To 50 MHz |
|---|---|---|
| AL | 0.3 div above 30 Hz | 1.5 div |
| LF Rej | 0.5 div above 50 kHz | 1.5 div |
| HF Rej | 0.5 div, 30 Hz to 50 kHz | —— |
| Dc | 0.3 div | 1.5 div |
| External | 70 mV | 350 mV |
| TV | Stable video rejection and sync separation from sync-negative NTSC or PAL composite video | |

**Trigger Jitter** — Nonstore Mode: 1 ns or less at 50 MHz. Storage Mode: ±1 sample period.
**External Trigger View** — Deflection Factor: Ext is 100 mV/div. Ext ÷ 10 is 1 V/div.
**External Trigger Input** — R and C = 1 MΩ paralleled by 33 pF (200 V dc + peak ac) maximum input.
**Acquisition Window Trigger Point** — Pretrigger: 7/8 of waveform occurs before trigger point. Midtrigger: 1/2 of waveform occurs before trigger point. Posttrigger: 1/8 of waveform occurs before trigger point.

### X-Y OPERATION (NONSTORE)

**Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical)** — 5 mV/div to 5 V/div with bandwidth of dc to 1 MHz. Phase difference is 3° from dc to 50 kHz.

### DISPLAY

**CRT** — 8 x 10 div (0.6 cm/div) display GH (P31) Phosphor standard. 12 kV operating potential.
**Graticule** — Internal. Vertical and horizontal centerlines marked in 5 minor div/major 0.6 cm/div.
**Z-Axis Input** — Range +3 V to +25 V with 1 MHz useable frequency range. Input resistance of at least 10 kΩ.

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Operating: 0°C to +55°C. Nonoperating: −25°C to +75°C. Option 01: −20°C to +55°C.
**Altitude** — Operating: To 4600 m (15,000 ft). Decrease maximum operating temperatures 1°C for each 1000 ft above 5000 ft. Nonoperating: To 15 000 m (50,000 ft).
**Vibration** — 0.025 p-p (4 g's at 55 Hz) displacement, 15 minutes along each axis from 10 Hz to 55 Hz.
**Humidity** — 120 hrs of MIL STD 202D, minus freezing and vibration.
**Shock** — 30 g half sine, 11 ms duration on each axis.

### OTHER CHARACTERISTICS

**Chart Output** — Clock Rate: Fast or slow. Amplitude: 500 mV/div. Output Impedance: 220 Ω.
**Calibrator** — Output Voltage: 0.3 V ±1%. Output Resistance: 5 Ω. Frequency: ≈1 kHz.
**Ac Power Requirements** — Line Voltage Ranges: 90 V to 132 V ac, 180 V to 250 V ac. Line Frequency: 48 Hz to 440 Hz. Power Consumption: 50 W maximum.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 237 | 9.3 |
| Height | 112 | 4.4 |
| Depth (Handle Not Extended) | 370 | 14.6 |
| Depth (Handle Extended) | 482 | 19.0 |
| **Weight** | **kg** | **lb** |
| Net | 5.0 | 11.1 |
| Shipping | 10.5 | 23.1 |

### INCLUDED ACCESSORIES

Two 10X P6148 Attentuator probes (010-6148-13); accessory pouch (016-0718-00); front panel cover (016-0719-00); CRT filter (378-0225-00); extender cables and board (067-1161-00); power supply load module (670-8133-00); operator's and service manuals.

## ORDERING INFORMATION

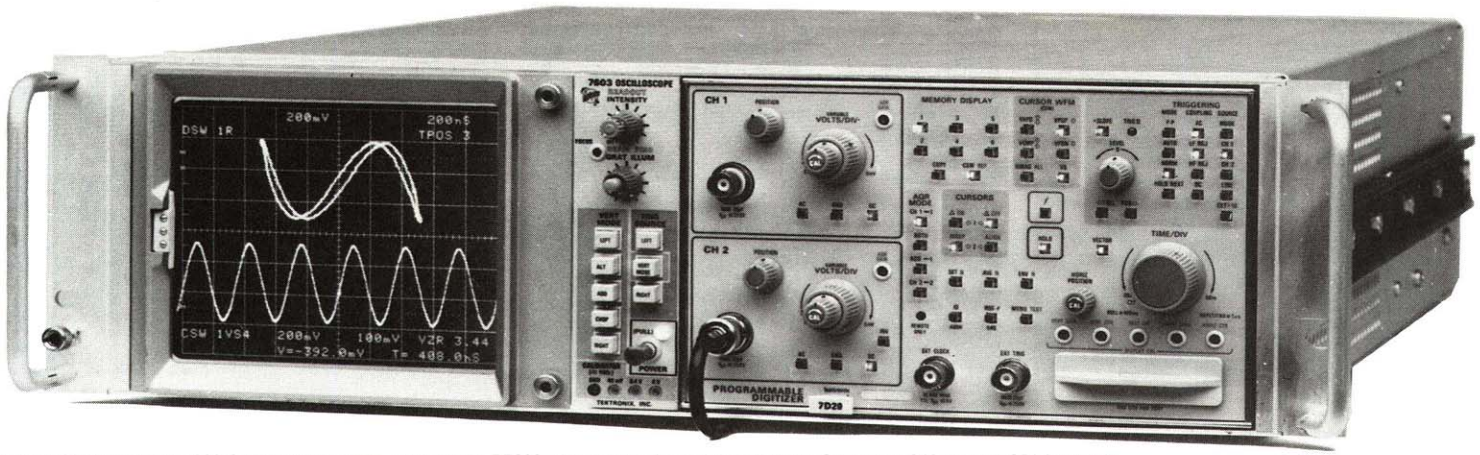
**336** Digital Storage Portable Oscilloscope ..... **$4,500**

**Option 01** — GPIB and Memory Option provides a GPIB interface (talk only). This transmits stored waveforms and scale factor information to a listener or controller. Extended waveform memory to store 16 additional waveforms at 2 waveforms/screen, for 16 k total additional memory is included .. **+$850**

### OPTIONAL ACCESSORIES

**Carts** — Order K212 or K117. Refer to page 429 for complete description.
**Camera** — Order C-30BP Option 01 ..... **$1,489**
**Camera Mounting Adaptor** — Order 016-0327-01 ..... **$170**

The SONY®/TEKTRONIX® 336 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 336 is available from Tektronix, Inc., its marketing subsidiaries and distributors.




*The 7D20 is used with 7000 Series oscilloscopes, such as the R7603, shown here, for rack installations. See pages 246 through 254 for details.*

## GPIB IEEE-488 7D20/7D20T

The 7D20 and 7D20T comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**Digital Storage for 7000 Series Mainframe (7D20)**

**70 MHz Bandwidth for Repetitive Signals**

**10 MHz Single-Shot Bandwidth**

**Two Channels Simultaneous Acquisition**

**Totally Programmable**

**Storage of Six Independent Waveforms**

**Enveloping and Signal Averaging**

**Cursor Measurements**

**Pretrigger and Posttrigger**

## TYPICAL APPLICATIONS

- **Ultrasonics**
- **Digital Design**
- **RF Modulation**
- **Automated Production Testing**

The 7D20 brings state-of-the-art digital performance to Tektronix 7000 Series mainframes and rackmounts.

The 7D20 is a GPIB programmable plug-in that is compatible with all 7000 Series mainframes (including the USM 281C) except the 7104. When combined with a 7000 Series mainframe, this plug-in creates a fully programmable, digitizing oscilloscope.

The 7D20T is the ideal high performance digitizer for automated systems applications not requiring a complete oscilloscope mainframe.

The 7D20T is supplied with its own power module, but without a display. Rear panel connectors provide X, Y, and Z output data for use with an external X-Y monitor, if desired.

Four feedthrough cables permit routing of input/output signals from the front panel of the 7D20T to the rear in rack-mounted applications. The GPIB cable may be connected to either the front or the rear of the 7D20T.

For those users who already own a 7D20 and would like to convert this 7000 Series plug-in into the 7D20T configuration, the power module itself is available as a 7D20T Option 01.

The capabilities and characteristics described here for the 7D20 also apply to the 7D20T.

The 7D20 can accurately measure the amplitude of a 50 ns wide transient event. Dual samplers simultaneously acquire two channels as if it were a "dual-beam" scope.

Beyond basic acquisition, the 7D20 offers signal averaging to reduce uncorrelated noise, envelope displays to compare dynamic characteristics of changing signals, pretrigger for viewing prior to the trigger event, storage of six independent waveforms plus a reference waveform, cursors for more accurate two-dot measurements, and user prompting and menu displays to improve user interface effectiveness.

### Digital Storage

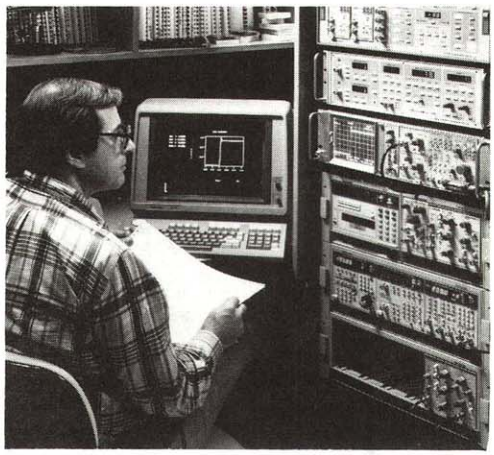
A 40 MHz maximum sampling rate provides approximately 10 MHz single-shot bandwidth and up to 70 MHz bandwidth with repetitive signals.

### Storage and Recall Front Panel Settings

Up to six different front panel set-ups can be stored and recalled as desired. These settings, plus the last panel setup, are saved in nonvolatile memory and are restored automatically when power is applied.

### Fully Automated Measurements

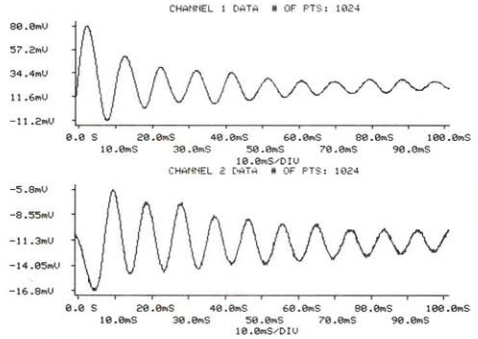
Since the 7D20 is completely programmable, fully automated measurement and testing is possible. Tektronix programmable signal sources, multifunction interface, and RF scanner provide and control the test signals while the 7D20 acquires waveforms for the computer or controller.



*The 7D20 is ideal for system applications of all sorts and supports many levels of automation, from menu driven to fully automated.*

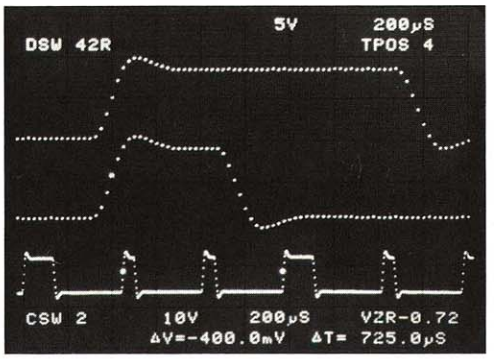
### Software Support

Utility and measurement software is available for the Tek 4041 System Controller to simplify common yet difficult GPIB programming tasks. Waveform processing and graphic ROM packs for the 4041 help to satisfy your data analysis and documentation requirements. Additionally, software support is provided for the Tek 4052A as well as a few selected non-Tektronix instrument controllers and technical computers.




*Archival hard copies can be produced by a system consisting of a 7D20 and mainframe, the Tektronix 4041 System Controller, 4105 Computer Display Terminal, and the 4695 Color Graphics Copier.*

### Measurement Flexibility

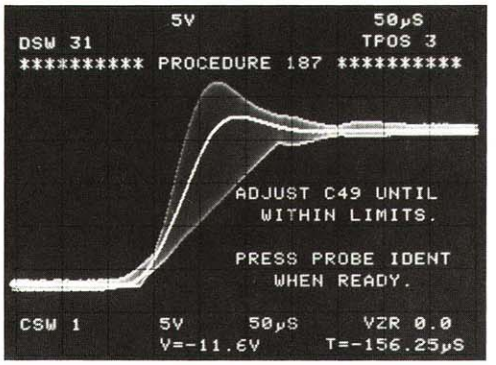



*View and compare two different portions of the same waveform or of two different waveforms. All of these waveforms have been repositioned and vertically compressed. The two upper waveforms, two pulses from a single pulse train, are magnified portions of the lowest waveforms. The time (ΔT) between the two cursors indicates the time between the leading edges of two pulses in the pulse train.*

### Hands Off Operation With Probe Identify Feature

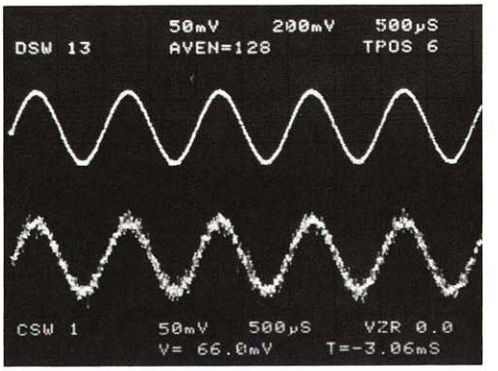
Recommended for use in interactive, computer-coordinated tasks, the Tektronix P6053B Probe allows computer routines to be sequentially activated at the 7D20's probe tip. This probe's "Identify" button signals the GPIB Interface via an input channel coded request. This capability allows the operator to work at a short distance from the 7D20 without the need to touch front panel controls. Two such probes may be used, one for each vertical channel.

### Automated Testing



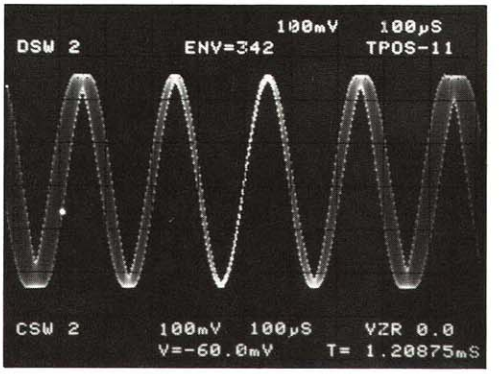

*For interactive test procedures, text messages, waveforms, and front panel set-ups may be transmitted and received from the 7D20 to a controller or computer. The procedure in this display informs the operator of the next task. Upper and lower tolerance limits are displayed as a single envelope. This envelope was initially constructed using the 7D20's envelope feature while a test signal was varied to its allowable limits. The waveform was then transferred and saved by the controller to serve as the test reference or overlay.*

### Signal Averaging



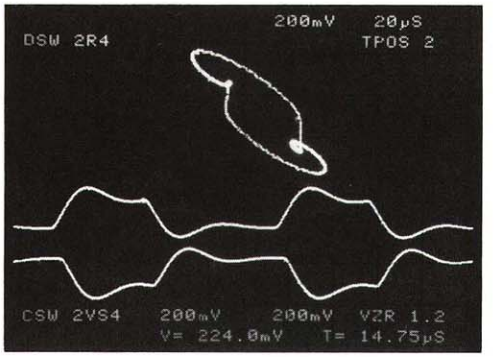

*Averaging reduces uncorrelated noise to improve measurement accuracy and display quality. Continuous and self-terminating averaging are provided. The self-terminating averaging processes a fixed number (N) of waveforms and then holds the result in memory. The N value is selectable from 8 to 256 in powers of 2. The top waveform in this display is the result of averaging the bottom waveform 128 times.*

### Enveloping




*Enveloping reveals subtle variations in signals by recording maximum and minimum values of recurring sweeps while vectors "paint" in the envelope. The effects of frequency shift are dramatically displayed.*

### X-Y Waveform Display and Time Reference

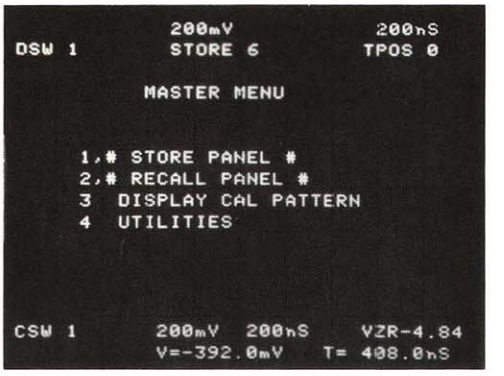



*Unique display capability allows viewing Y versus X events and Y versus time simultaneously. X-Y channels are matched at 10 MHz with <2° of phase shift.*

### Cursor Measurements

Accurate amplitude measurements (referenced to ground) and time measurements (referenced to trigger position) are made using one cursor. Point-to-point difference (Δ) measurements are made using two cursors.

### Master Menu




*The master menu offers a convenient way to enable special functions such as the Store and Recall of front panel settings and also allows you to branch-out to other menus.*

*The 7D20T consists of the 7D20 and its own dedicated power module, for use in applications not requiring local visual display of acquired signals.*

## CHARACTERISTICS

### VERTICAL SYSTEM

**Input** — Two channels, simultaneous sampling, BNC connectors.

**Acquire Modes** — CH 1, CH 2, Add, Both (dual channel).

**Sensitivity** — 5 mV to 5 V/div; 1-2-5 sequence.

**Bandwidth** — 70 MHz maximum. (Ac Coupled Low Frequency Response: 10 Hz or less.)

**Step Response** — 5 ns or less.

**Input Impedance** — 1 MΩ paralleled by ≈20 pF.

**Maximum Input Voltage** — Dc Coupled: 250 V, 1 kHz or less (dc + peak ac). Ac Coupled: 400 V, 1 kHz or less (dc + peak ac).

**Signal Isolation** — 100:1 dc to 20 MHz.

**Vertical Resolution** — 8 bits, 256 levels, 0.04 div/level.

**Gain Ratio Accuracy** — <2%. Maximum error throughout the V/div range with acquire gain calibrated at 10 mV/div. Measurement valid with Cursors or GPIB.

**Noise** — Mean value of 50 measurements taken at 0.02 div increments.

| Volts/Div | Full Scale/RMS Noise | Percent of Full Scale |
|---|---|---|
| 5 mV | 52 dB | 0.25 |
| 10 mV to 5 V | 55 dB | 0.18 |

*NOTE: Full scale = 10.24 divisions.*

**Phase Match X-Y** — <2° from dc to 10 MHz.

### HORIZONTAL SYSTEM

**Time Division Range** — External Clock, 20 s/div to 50 ns/div in 1-2-5 sequence.

**Digitizing Technique Versus Time/Division** — Real Time (Rolling Display): External Clock, 20 s/div to 0.1 s/div. Real Time: 50 ms/div to 500 μs/div. Extended Real Time: 200 μs/div to 2 μs/div. Equivalent Time: 1 μs/div to 50 ns/div.

*Note: Single events can be captured as fast as 2 μs/div. For 1 μs/div to 50 ns/div, repetitive events are required to build a complete waveform.*

**Time Measurement Accuracy** — One Cursor: 0.1% of reading +0, −1 sample interval ±300 ps. Two Cursors: 0.1% of reading ±600 ps.

**Horizontal Resolution**

| Time/Division | Points/ Waveform | Resolution Points/Division |
|---|---|---|
| External, 20 s to 500 μs | 1024 | 100 |
| 200 μs to 2 μs | 820*1 | 80*1 |
| 1 μs to 50 ns | 1024 | 100 |

*1 *Waveform interpolation to 1024 points is available for transfer over the GPIB Interface.*

**Trigger Position**

Pretrigger: 0 to 10 div in 1 div increments. Posttrigger (delay): 0 to 1500 div in 1 div increments (disabled during Roll with Envelope or Average).

| | Frequency Range*1 | Sensitivity | |
|---|---|---|---|
| | | Internal | External |
| Normal (Dc Coupling) | dc to 30 MHz | 0.4 div | 60 mV |
| | 30 MHz to 70 MHz | 1.0 div | 150 mV |
| P-P and Auto | 30 Hz to 200 Hz | 2.0 div | 300 mV |
| | 200 Hz to 30 MHz | 0.6 div | 90 mV |
| | 30 MHz to 70 MHz | 1.2 div | 200 mV |

*1 *The ac coupling low frequency limit is 30 Hz. In Time/Div settings of 1 μs to 50 ns, when using P-P or Auto, low-frequency limit is 300 Hz.*

### SIGNAL PROCESSING

**Cursors Readout** — With one cursor (ΔOff), vertical and horizontal coordinate values are referenced to zero volts and the trigger position as zero time. With two cursors (ΔOn), vertical and horizontal coordinate values are the difference between the two cursors.

**Signal Averaging**

AVE N: A self-terminating, stable average processing "N" number of waveforms and then holds the result in memory. The "N" value may be selected using the SET N function (N = 8, 16, 32, 64, 128, 256).

AVE: A continuous, stable averaging process. N waveforms are averaged as in AVEN, then additional waveforms are weighted at 1/N. In Roll mode a running average (smooth) is available to provide high frequency filtering.

**Enveloping**

ENV N: A self-terminating recording of waveform maxima and minima. When N waveforms are processed, the result is held in memory.

ENV: A continuous (infinite) recording of waveform maxima and minima.

**Waveform Modifiers**

VPUP ↑ (Vertical Position Up), VPDN ↓ (Vertical Position Down): Provide vertical positioning control of any stored waveforms.

VCMP ↕ (Vertically Compress), VXPD ↕ (Vertically Expand): Provide vertical display expansion or compression. Two expansions or compressions in 1,2,5 calibrated steps, from the original V/div are available.

HMAG (Horizontal Magnify): Displays the cursor waveform horizontally magnified by a factor of 10. HMAG ALL (Horizontally Magnify All Waveforms): Displays all waveforms at 10 times horizontal magnification.

VS (Versus): Creates a Y versus X display of any two waveforms.

### GPIB INTERFACE

Interface Function Subsets Implemented:

| | |
|---|---|
| SH1 | Complete source handshake |
| AH1 | Complete acceptor handshake |
| T5 | Complete talker — no secondary address |
| L3 | Complete listener — no secondary address |
| SR1 | Complete service request |
| RL1 | Complete remote local |
| DC1 | Complete device clear |
| DT1 | Complete device trigger |
| PPØ | No parallel poll |
| CØ | No controller |
| E2 | Three state |

**Programmable Functions** — All instrument setting and operating modes are programmable except for Variable V/Div and Horizontal Position. However, these uncalibrated controls can be overridden and forced into the "CAL" position on command from the GPIB Interface. The display of Menu and ID is selectable from the front panel only.

**Format** — Device dependent commands in ASCII. Waveform data points selectable as BINARY or ASCII.

**Waveform Output Time** — 250 ms minimum for BINARY and 2.5 s minimum for ASCII. Actual transfer times depend upon the speed of the receiving device.

### INPUTS

**External Trigger (Front Panel)** — Maximum Input Voltage: 250 V (dc + peak ac).

**Signal Input Impedance** — 1 MΩ, paralleled by ≈20 pF.

**Hold Next (Mainframe Rear Panel)** — Initiates Hold Next condition; connected to Single Sweep Reset connector.

### OUTPUTS

**Hold Next Ready** — High level indicates unit is in Hold Next condition; output level remains low when unit is not in Hold Next condition; connected to Single Sweep Ready connector.

**+Gate Out** — Provides high level output signal for duration of waveform/character readout.

### PLUG-IN COMPATIBILITY

The 7D20 is compatible with all 7000 Series mainframes with the exception of the 7104 mainframe. Use with the 7104 will void the 7104 warranty.

### PHYSICAL CHARACTERISTICS

| | 7D20 | | 7D20T | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 206 | 8.1 | 216 | 8.5 |
| Height | 127 | 5.0 | 183 | 7.2 |
| Depth | 371 | 14.6 | 566 | 22.3 |
| **Weight** | **kg** | **lb** | **kg** | **lb** |
| Net | 3.6 | 8.1 | 10.4 | 23.0 |
| Shipping | 8.0 | 17.8 | 12.0 | 26.6 |

**Included Accessory** — Instruction manual.

## ORDERING INFORMATION

**7D20** Programmable Digitizer (Plug-in) **$8,055**

**7D20T** Programmable Digitizer ..... **$9,655**

**7D20T Option 01** Power Module (Converts Existing 7D20 to 7D20T) ..... **−$8,055**

**Utility Software**

For 7D20/7D20T/4041. Order 062-6959-01 ..... **$150**

For 7D20/7D20T/4052A. Order 062-6961-01 ..... **$150**

Refer to page 323 for description and ordering information.

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

**Option A5** — Switzerland 220 V/10 A, 50 Hz

### RECOMMENDED PROBE (7D20 and 7D20T)

**P6053B Identify Probe** — For remote service request via probes "Identify" button. 10X attenuation; 200 MHz bandwidth; scale factor coding; 6 ft. Order 010-6053-13 ..... **$170**

### RECOMMENDED MAINFRAME FOR 7D20

**R7603 Option 20** — The R7603 mainframe provides a 6-inch diagonal CRT display and three-wide plug-in compartment in a 5.25 inch high rackmount configuration. Option 20 permits rear panel access to the 7D20's GPIB Interface and includes cable 175-7151-00 required inside 7D20. See page 240 for further information. Order R7603 Option 20 Mainframe ..... **$3,635**

### OPTIONAL ACCESSORY (R7603)

A field installable kit adds Option 20 to the standard R7603. Intended for use with a previously purchased R7603, this kit provides parts to connect the 7D20's GPIB Interface to the R7603 mainframe.

Order 040-1093-00 ..... **$380**

### CONVERSION KITS

**Cabinet-to-Rackmount** — Equipped with slide-out assembly to rackmount a 7D20T to the left of a 4041 or another 7D20T. Order 040-1147-00 ..... **$200**

**Cabinet-to-Rackmount** — Equipped with slide-out assembly to rackmount a 7D20T to the left of a TM 5003. Order 040-0984-01 ..... **$190**

**Cabinet-to-Rackmount** — Equipped with slide-out assembly to rackmount a 7D20T to the left of a blank plug-in compartment.

### TIME AND AMPLITUDE MEASUREMENT SOFTWARE

This software package is available on a 5¼ inch flexible disk which supports the 7D20 in combination with either the HP9826 or HP9836 technical computers. Order part number 062-7618-01. Order may be placed through Central Parts Ordering (CPO) for your area. See page 12 ..... **$950**

### COMPLETE PACKAGE CONFIGURATION

For a complete 7D20T with 4041 System Controller and accessories configuration, see the MP 2401 page 349.

GPIB IEEE-488

# 7854

The 7854 is designed to support other products which comply with IEEE Standard 488-1978.

**Waveform Parameters at the Touch of a Key**

**Dc to 400 MHz Bandwidth at 10 mV/div**

**Calibrated Sweep Rates to 500 ps/div**

**Stores Repetitive Waveforms up to 400 MHz (Up to 14 GHz with Sampling Plug-Ins)**

**Single Shot Events and Pretrigger Up to 50 μs/div (with 7B87 Time Base)**

**Signal Averaging**

**Resolution Up to 0.01 Div on Stored Data (10 Bits)**

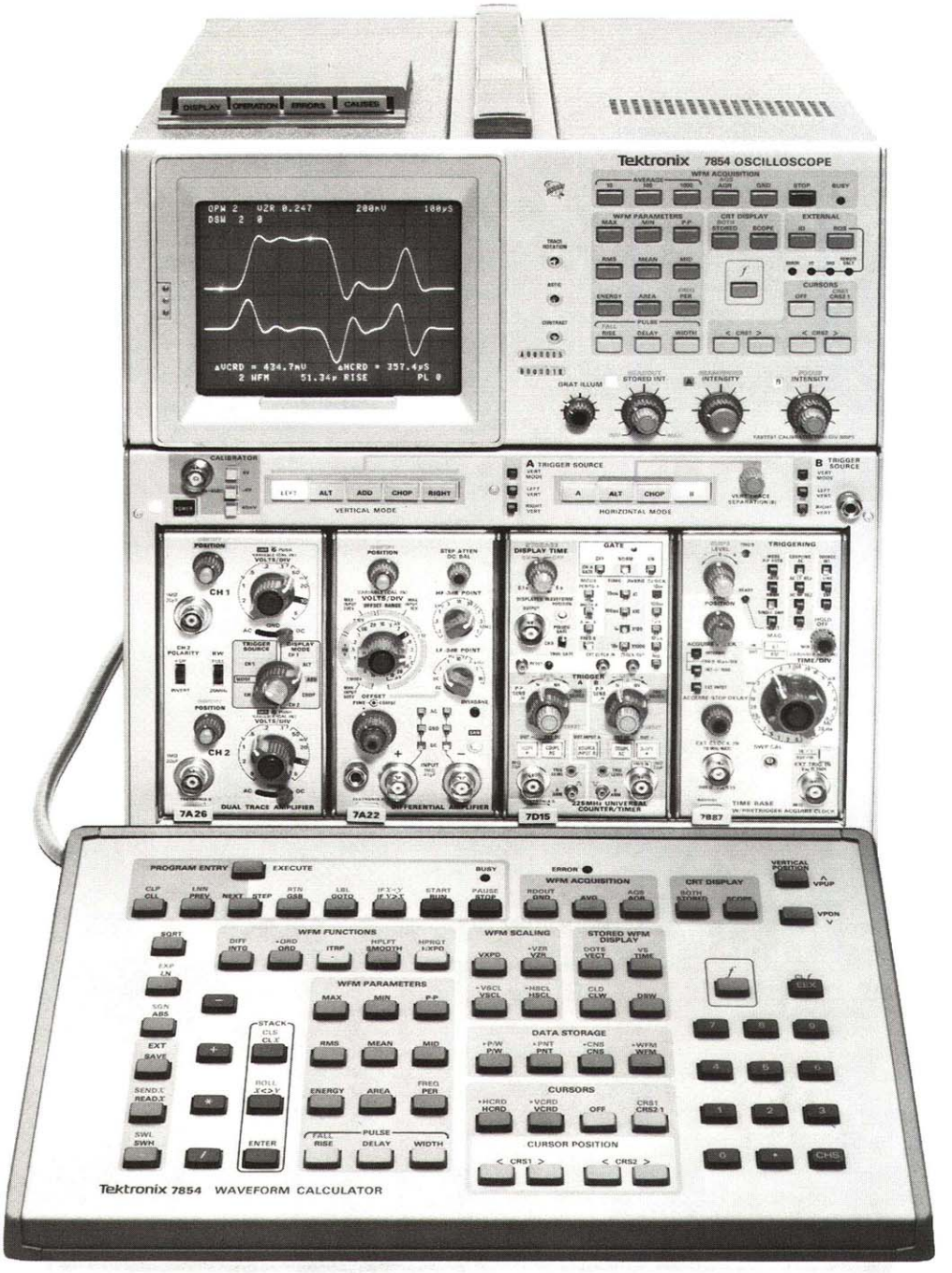
**Choose 128, 256, 512, 1024 Points/Waveform**

**Keystroke Programming (Up to 2000 Keystrokes with Option 2D)**

**GPIB Interface (Standard)**

## TYPICAL APPLICATIONS

- **Power Supply Testing**
- **Semiconductor Testing**
- **Fiber Optics**




The 7854 Waveform Processing Oscilloscope represents a unique approach to today's test and measurement problems. It combines the features of a high performance real time oscilloscope with digital storage and waveform processing. When integrated with any of a wide variety of 7000 Series plug-ins, it becomes a very powerful measurement system. The 7854 offers programmable measurement routines, GPIB interface for mass data and program storage plus simultaneous display of real time and stored waveforms. The 7854's on-board memory can store up to 40 waveforms and 2000 keystrokes with Option 2D.

Mainframe and calculator keyboard functions provide cursor control and waveform parameter information at the touch of a button, e.g., maximum, minimum, peak-to-peak, rise. Additional features on the calculator keyboard enable arithmetic manipulation of waveforms such as differential, integral, log, and absolute value.

Signal averaging can recover signals buried in random noise and improve measurement accuracy. One or two cursors are selectable for voltage and time measurements. One cursor provides voltage measurements referenced to ground and time measurements referenced to time zero. Two cursors enable Δtime and Δvoltage measurements. Cursors may also be used to bracket an area of interest for measurement consideration.

For single-shot applications, the 7B87 Time Base plug-in allows storage of events that occur prior to a trigger (pretriggering). The amount of pretrigger data may be varied continuously from 0.2 divisions of pretrigger to 9.9 divisions.

The 7854's keystroke programming (simply storing a series of keystrokes to be executed) assures repeatable measurement results and lowers the skill level needed to operate the system. Measurement loops can be written to save time, log results and make pass/fail decisions. Full subroutine and conditional branching capabilities are provided.

## CHARACTERISTICS

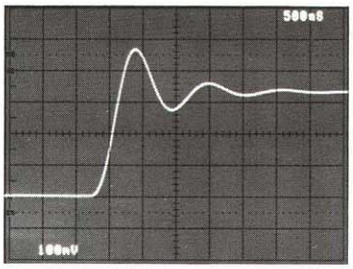
### VERTICAL REAL TIME SYSTEM

**Input** — Two plug-in compartments; compatible with 7000 Series plug-ins.

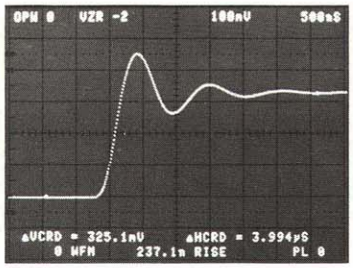
**Modes of Operation** — Left, Alt, Add, Chop, Right.
**Mainframe Bandwidth** — 400 MHz with 7A29 or 7A19 Amplifier plug-in.
**Mainframe Step Response** — 0.9 ns or less with 7A29 or 7A19 Amplifier plug-in.
**Chopped Mode** — Chop rate is ≈1 MHz.
**Delay Line** — Permits viewing leading edge of displayed waveform (7B50 Series time bases not recommended for 7854 except 7B50A).
**Trace Separation Range** — In dual-sweep modes, B trace can be positioned 4 div above or below the A trace.

### CRT AND DISPLAY FEATURES

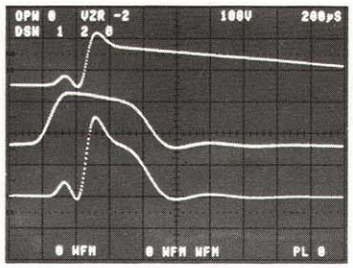
**CRT Display Modes**
Scope (Conventional display.)
Stored (Digital data display.)
Both (Stored display plus real time waveforms.)
Program Entry (User program text display.)



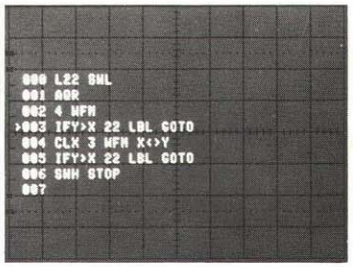

*Conventional Scope: In the SCOPE mode, the 7854 provides a complete plug-in scope giving standard displays like other Tektronix high performance scopes.*




*Storage Scope: Risetime is calculated by pushing a single key. Time and voltage differences between cursors are shown on the line above risetime.*




*Multiple Storage and Calculation: Volts, current, and power are all shown on the display. Power is a simple two or three keystroke calculation.*




*Waveform Processing: Keystroke Programming enables the user to design measurement routines tailored to individual tests or experiments.*

### HORIZONTAL REAL TIME SYSTEM

**Input** — Two plug-in compartments; compatible with 7000 Series plug-ins. 7000 Series vertical amplifiers and specialized plug-ins may also be used.*1 The 7B87 is recommended for pretrigger and single shot digitizing.
**Modes of Operation** — A, Alt, Chop, B.
**Fastest Calibrated Sweep Rate** — 0.5 ns/div.
**Chopped Mode** — Rep rate is ≈200 kHz.
**X-Y Mode** — Phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz without phase correction, (dc to 1 MHz with phase correction, B horizontal only, Option 02).
*1 *See plug-in compatibility for exceptions for digital storage.*

### PROGRAM STORAGE

Keystroke programming allows the mainframe to remember a sequence of keystrokes (with remote waveform calculator or GPIB*1).
**Editing** — Line by line editing capability.
*1 *Mainframe vertical and horizontal modes and all other keys except edit commands are programmable.*

### DIGITAL STORAGE

**Equivalent Time Bandwidth** — 400 MHz. See 7000 Series system bandwidth specifications.
**Accuracy** — Refer to plug-in specifications.
**Acquisition Channels** — One or two simultaneous channels (Plug-in Chop mode not valid).
**Acquisition Window** — ±5 div from center screen both vertical and horizontal.
**Resolution**
Vertical: 0.01 div.
Horizontal: Selectable points/waveform on remote keyboard.

| Horizontal Resolution (divs) | Points/Waveform |
|---|---|
| 0.01 | 1024 |
| 0.02 | 512 |
| 0.04 | 256 |
| 0.08 | 128 |

### PLUG-IN COMPATIBILITY

All 7000 Series plug-ins are compatible in the standard oscilloscope display mode. The 7L5 and 7L18 Spectrum Analyzers require factory modification for optimum use with digital storage operation. The 7D01, 7D02 and 7T11 are not compatible in Stored mode.

The 7B87 provides pretrigger for the 7854. Pretrigger allows you to view what has occurred before the trigger event in single shot applications. The amount of pretrigger time is determined by the Acquire-Stop delay time setting. The total amount of pretrigger is 0.2 to 9.9 times the time/div setting.
**Single Shot Performance** — Using 7B87 with 7854 Internal clock.
**Ext Clock** — 2 μs/point maximum.

| Fastest Sweep (Time/Div) | Points/Waveform |
|---|---|
| 50 μs | 128 |
| 100 μs | 256 |
| 200 μs | 512 |
| 500 μs | 1024 |

### OUTPUTS/INPUTS

**+Sawtooth** — Positive-going with baseline at 0 V ±1 V into 1 MΩ. Voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω. Output R is ≈950 Ω.
**+Gate** — Positive pulse of the same duration and coincident with sweep. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Output R is ≈950 Ω. Source is selectable from A gate, B gate, or Delayed gate.
**Vertical Signal Out** — Selected by A Trigger Source switch. Output voltage is 0.5 V/div into 1 MΩ, 25 mV/div into 50 Ω. Output R is ≈950 Ω. Bandwidth depends upon vertical plug-in.
**Remote Single Sweep Reset** — Rear panel BNC, ground closure activated.

### MEMORY FORMAT

| | STANDARD | | | | OPTION 2D | | | |
|---|---|---|---|---|---|---|---|---|
| Points Per Waveform*1 | 128 | 256 | 512 | 1024 | 128 | 256 | 512 | 1024 |
| Maximum No of Waveforms | 16 | 8 | 4 | 2 | 40 | 20 | 10 | 5 |
| Maximum No of Constant Registers | 50 | | | | 100 | | | |
| Maximum No of Prog Commands plus lines | 920 | | | | 2000 | | | |

*1 *Unless otherwise selected, default value is 512 at power-up.*

**TTL Output** — Rear panel BNC, TTL output under remote keyboard control (SWH and SWL).
**External Z-Axis Input** — 2 V p-p for full intensity range from dc to 1 MHz. Positive signal blanks the trace. Maximum input voltage is 15 V (dc plus peak ac).
**Camera Power Output** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.
**Memory Back-Up Power Input** — 6.0 V to 6.5 V at 0.7 amp to preserve stored data if mainframe's power is interrupted.

### GPIB INTERFACE

Interface Function Subsets Implemented:

| | |
|---|---|
| SH1 | Complete source handshake |
| AH1 | Complete acceptor handshake |
| T5 | Talker function |
| L3 | Listener function |
| SR1 | Complete service request capability |
| RL1 | Complete remote/local capability |
| DC1 | Complete device clear capability |
| DT1 | Complete device trigger capability |

**I/O Records** — Waveforms constants, program text, and display text.
**End of Message Terminator (Selectable in Talk/Listen Mode for EOI or LF/EOI).** — Compatible with Tektronix and other popular controllers.
**Device Address** — Selectable via rear panel switch.
**Remote Operation** — All keystroke functions and vertical and horizontal modes can be remotely operated via the GPIB.

### CALIBRATOR

**Voltage Output** — Squarewave, positive-going from ground. Ranges are 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%; rep rate is 1 kHz within 0.25%.
**Current Output** — 40 mA available through Calibrator output with optional BNC to current loop adaptor.

### POWER REQUIREMENTS

**Line Voltage Ranges** — 90 V to 132 V. 180 V to 250 V.
**Line Frequency** — 48 Hz to 440 Hz.
**Maximum Power Consumption** — 230 W.

### PHYSICAL CHARACTERISTICS

| Dimensions, Mainframe | mm | in |
|---|---|---|
| Width | 305 | 12.0 |
| Height | 348 | 13.7 |
| Depth | 627 | 24.7 |
| **Waveform Calculator** | **mm** | **in** |
| Width | 277 | 10.9 |
| Height | 69 | 2.7 |
| Depth | 165 | 6.5 |
| Cord Length (within 76 mm) | 1420 | 56.0 |
| **Weights** | **kg** | **lb** |
| Net | 20.4 | 45.0 |
| Shipping | 28.2 | 62.0 |

### INCLUDED ACCESSORIES

Power cord (161-0066-00); BNC-to-BNC cable (012-0208-00); instruction manual.

## ORDERING INFORMATION
**(PLUG-INS NOT INCLUDED)**

**7854** Oscilloscope (Including Waveform Calculator) ..... **$14,930**
**Option 02** — X-Y Phase Correction ..... **+$250**
**Option 03** — EMC Modification ..... **+$375**
**Option 2D** — 4 k Expanded Memory ..... **+$250**
**Field Option 2D Kit** — Order 040-0941-00 ..... **$300**
**Option 78** — BE (P11) Phosphor ..... **+$100**

### INTERNATIONAL POWER CORDS & PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A,50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

**7B87** Time Base required only for pretrigger and single shot digitizing. See page 258 for complete description ..... **$1,695**

### SYSTEMS

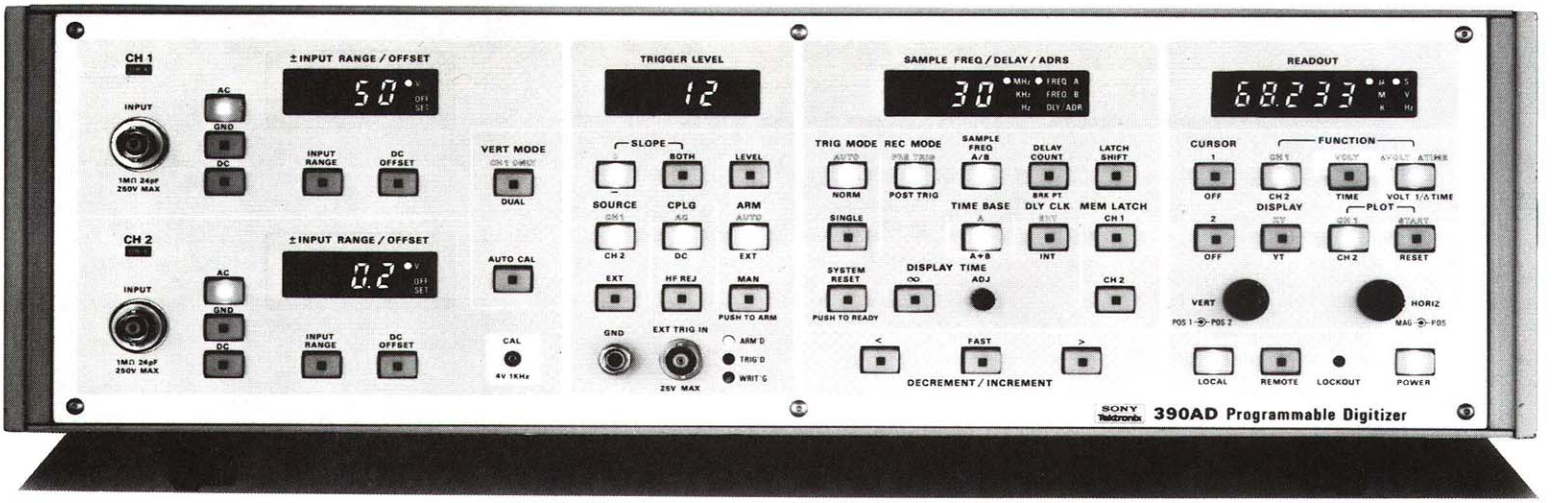
**The 7854 is also available as a MP 2501 Acquisition/Processing Package. This system is a synergistic combination of the Tektronix 7854 Oscilloscope and 4041 Controller. Together, these two instruments automate the entire waveform test and measurement process, from acquisition and calculation to storage and display formatting.**

**Recommended Cart** — The Scope-Mobile® Cart Model 3 is recommended for all 7000 Series mainframes. A keyboard tray for the 7854 and a storage area for plug-ins are available upon request. Contact your Tektronix representative for price and delivery.

**Tektronix offers service training classes on the 7854 Waveform Processing Oscilloscope.**

**For further training information, contact your local Sales/Service Office or request a copy of the on the Tektronix Service Training Catalog on the return card in the center of this catalog.**

# SONY/TEKTRONIX® PROGRAMMABLE WAVEFORM DIGITIZER




## GPIB IEEE-488 390AD

The 390AD complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

**True Dual Channel 30 MHz Sampling Rate (60 MHz in Single Channel Mode)**

**10-Bit Resolution**

**2048 Word Memory Per Channel (4096 Single Channel Mode)**

**Cursor-Based Measurements**

**Sample-Rate Switching**

**Direct Plotter Output Capabilty**

## TYPICAL APPLICATIONS

- **Extracting Information from Signals Containing Components from dc to 15 MHz**
- **Ultrasonics/Stress/Strain**
- **Mechanical/Vibration**
- **Audio**
- **ATE**
- **Laser Spectroscopy**
- **Biomedical Research**
- **LIDAR**
- **Geo-Seismic**

Used for low-to-medium-speed signals, the 390AD Programmable Waveform Digitizer provides crystal-controlled, 30-MHz sampling on two channels. Or, a single channel of data may be digitized at up to 60 megasamples per second.

Features include 10 bit vertical resolution, dual-channel synchronized digitizing, pretriggering and posttriggering, sample-rate switching during acquisition, internal cursors for two-point time or voltage measurements and 2048 words of memory per channel. Excellent dynamic accuracy is achieved using a two-stage flash-conversion process.

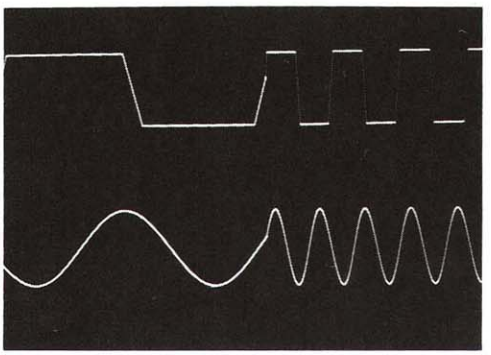


*Figure 1. Photo showing sample of Rate Switching. In this example switching occurs at the 1024th sample, to extend the display window. The sample rate can be either increased or decreased at the trigger point. A minor time discontinuity may occur at the trigger point under some conditions.*

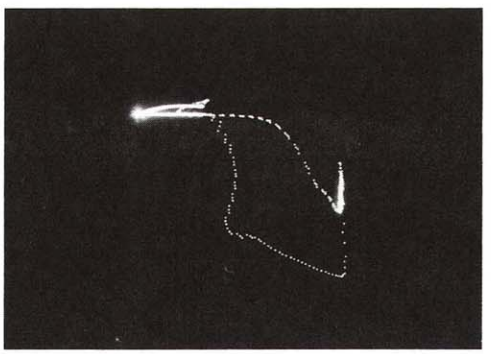


*Figure 2. The 390AD display is set to X vs Y mode.*

The X versus Y display mode coupled with the shift mode function provides a powerful tool for visual comparison of related phenomena.

To ensure reliable operation and high accuracy, the 390AD includes Auto Cal (self-calibration) and self-test features during operation.

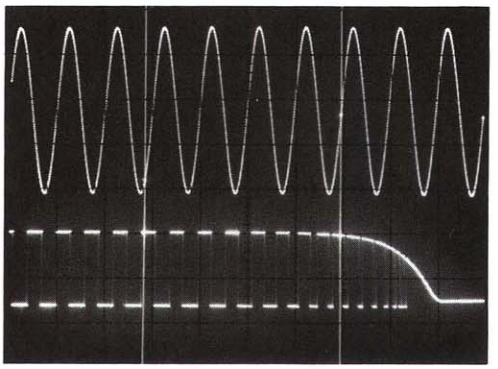


*Figure 3. Two cursors may be positioned by the user or controller, at points of interest on either waveform. The voltage difference, time difference, or 1/time difference, as well as the absolute values may be directly read from the LED display, or sent to a controller. Positioning may be precisely accomplished with the aid of the "zoom" feature.*

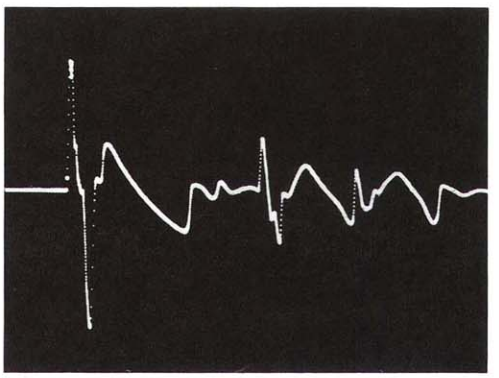


*Figure 4. Complex manual setups may be avoided by recording the desired instrument settings for a particular measurement on a system peripheral device, then sending the English-like command string to the 390AD.*

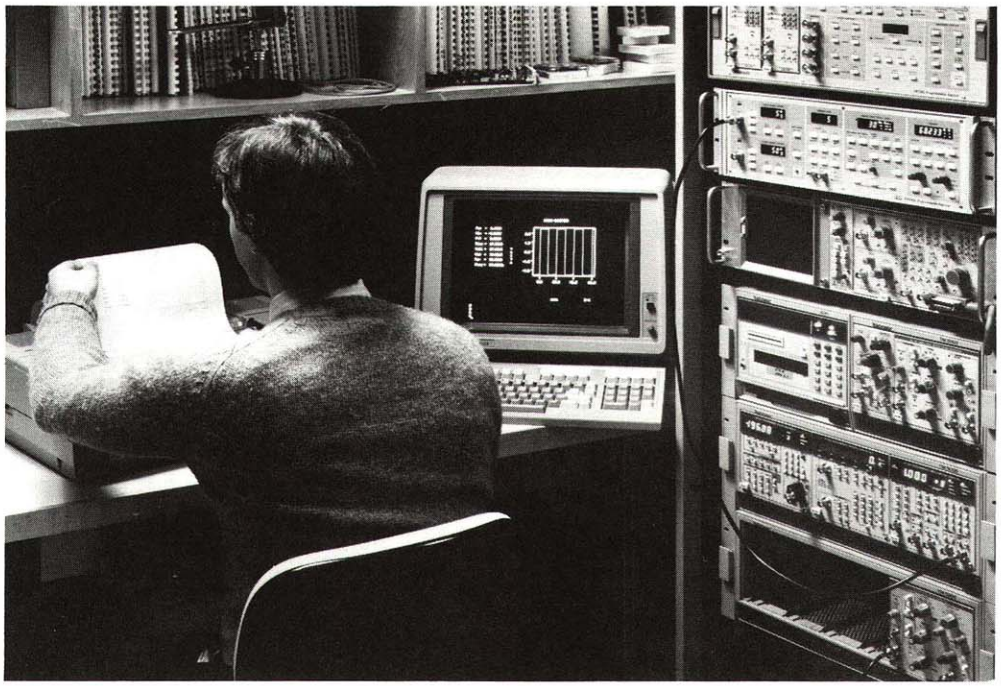


*Figure 5. The 390AD can be easily integrated into wide range of GPIB systems. Shown above is a 4695 Color Hard Copy Unit and a 4105 Color Terminal which is connected to a Tektronix 4041 System Controller.*

## CHARACTERISTICS

### VERTICAL

**Input Channels** — Two, single ended.

**Sensitivity** — ±100 mV to ±50 V full scale (200 mV p-p to 100 V p-p) 9 steps, 1-2-5 sequence.

**Input R and C** — 1 MΩ ±2%; paralleled by ≈24 pF.

**Maximum Input Voltage** — Dc Coupled: 250 V (dc + peak ac). Ac Coupled: 500 V (dc + peak ac).

**Bandwidth** — Dc to 15 MHz (−3 dB). Lower −3 dB point, Ac Coupled: 10 Hz.

**Input Dc Offset Voltage** — 0 to ±99% full scale, 1% step. Accuracy: <0.5%.

**Automatic Calibration** — Gain Accuracy: ±0.4%. Dc Drift Accuracy: <±0.1%.

### TIME-BASE A AND B

**Sample Rate** — Internal: CH 1 Only: 5 Hz to 60 MHz, 23 steps, 1-2-5 sequence except 30 MHz and 60 MHz. Dual: 5 Hz to ≈30 MHz, 22 steps. External: Dc to 60 MHz.

**Clock** — 60 MHz ±10 ppm, crystal-controlled.

### TRIGGERING

**Sources** — Internal CH 1 and CH 2 or external.

**Coupling** — Ac, dc, HF Rej.

**Slope** — Positive, negative, both.

**Level Range** — Internal: 0 to ±99% full scale, 1% step. External: ±4.95 V, 0.05 V step.

**Trigger Sensitivity**

| Coupling | Trigger Frequency Range | Minimum Signal Required | |
|---|---|---|---|
| | | Internal | External |
| Ac | 25 Hz to 15 MHz | 30 LSB | 300 mV p-p |
| HF Rej | 25 Hz to 50 kHz | 30 LSB | 300 mV p-p |
| Dc | Dc to 15 MHz | 30 LSB | 300 mV p-p |

**Arming** — Auto, Manual, External.

### DIGITIZING

**Vertical Resolution** — 10 bits ($^1/_{1024}$).

**Sample Rates** — Dual Channel Mode: 30 MHz. CH 1 Only Mode: 60 MHz.

**Aperture Jitter (Including Internal Clock)** — 150 ps, nominal.

**Dynamic Accuracy*[1]**

| Signal Frequency | Effective Bits |
|---|---|
| ≤1 MHz | ≥8.75 |
| ≤10 MHz | ≥8.25 |
| ≤14 MHz | ≥7.75 |

*[1] *Sampling frequency at 30 MHz. For further information refer to HANDSHAKE Vol 5 No 1, 33-A-4463.*

**Record Length** — Dual Channel Mode: 2048 words/channel. CH 1 Only Mode: 4096 words.

**Modes** — Auto, Norm, Single.

**Pretrigger Range** — CH 1 Only Mode: 0 to 4092. Dual Channel Mode: 0 to 2046.

**Posttrigger Range**

| Time Base | Vertical Mode | Range |
|---|---|---|
| A | Dual | 0 to 9998 |
| | CH 1 only | 0 to 9998 |
| A+B | Dual | 0 to 2046 |
| | CH 1 only | 0 to 4092 |

**A Time Base** — Recording is taken at one rate (sample frequency A) continuously.

**A+B Time Base** — Pretrigger Mode: Sample frequency A is switched to B at trigger. Recording stops at delayed trigger. The transition point (switch point) is well defined. Posttrigger: Sample frequency A is switched to B at delayed trig and recording stops after total of 2048 (or 4096) samples.

Stored digital data are addressable by key entry while monitoring cursors on the waveform.

**Readout Display** — Five digit LED (Reads voltage difference on the same waveform or between CH 1 and CH 2, absolute voltage, time interval, and 1/T.

### OUTPUTS

**CRT Display** — X: 1 V p-p Ramp (changeable to 5 V p-p by internal strap). 8 ms: Dual. 16 ms: CH 1 only. Mag gain X1 to X10 variable. Y: 1 V p-p (changeable to 5 V p-p by internal strap). Z: 0 to 1 V (changeable to 0 to 5 V by internal strap), selectable polarity. X-Y Plot: Output Voltage is 0 to 5 V. Plot Speed is 20, 50, 100 ms/word: Auto Slow, or Auto Fast modes. (Modes are selected by internal strap.)

**Voltage Calibrator** — Rectangular 1 kHz (±$10^{-5}$), 4 V (±1%).

**Rear Panel Connectors** — CRT-X, CRT-Y, CRT-Z, INT CLK-OUT, EXT CLK-IN, EXT ARM-IN, EXT DLY CLK-IN, PLOT-X, PLOT-Y, PLOT-PEN, WRITE END, GPIB.

### GPIB INTERFACE

**Standard** — Conforms to IEEE Standard 488-1978.

Interface Function Subsets Implemented:

| | |
|---|---|
| SH1 | Complete source handshake |
| AH1 | Complete acceptor handshake |
| T6 | Basic talker |
| L4 | Basic listener |
| SR1 | Complete service request capability |
| RL1 | Complete remote/local capability |
| PP0 | No parallel poll |
| DC1 | Complete device clear capability |
| C0 | No controller function |
| DT1 | Complete device trigger capability |

**Interface Control Message** — GTL, LLO, SDC-DCL, GET, SPE-SPD, IFC.

**Programmable Functions** — All instrument setting and operating modes are programmable, except power switch, vertical/horizontal position, horizontal mag, and external clock switch.

**Format** — Commands in ASCII, Waveform data in 2 byte/point high byte first.

### ENVIRONMENTAL CHARACTERISTICS

**Temperature Range** — Operating: 0°C to +40°C. Nonoperating: −25°C to +70°C.

**Altitude** — Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).

**Line Voltage Range** — 90 V ac to 132 V ac (115 V); 180 V to 250 V ac (230 V).

**Line Frequency** — 48 Hz to 440 Hz.

**Power Consumption** — 240 W.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 446 | 17.6 |
| Height | 152 | 6.0 |
| Depth | 540 | 21.3 |
| **Weights** | **kg** | **lb** |
| Net (without accessories) | 15.5 | 34.0 |

### INCLUDED ACCESSORIES

Power cord (161-0066-00); GPIB cable (012-0630-03); two 4 A fast-blow fuses (159-0017-00); 390AD Programming Aid (070-4467-00); instruction manual.

## ORDERING INFORMATION

**390AD** Programmable Digitizer ..... **14,530**

**Option 10** — Rackmount 390AD ..... **+$250**

**Utility Software**

For 390AD/4041. Order 062-6959-01 ..... **$150**

For 390AD/4052A. Order 062-6960-01 ..... **$150**

Refer to page 323 for description and ordering information.

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

**Option A5** — Switzerland 220 V/10 A, 50 Hz

### OPTIONAL ACCESSORIES

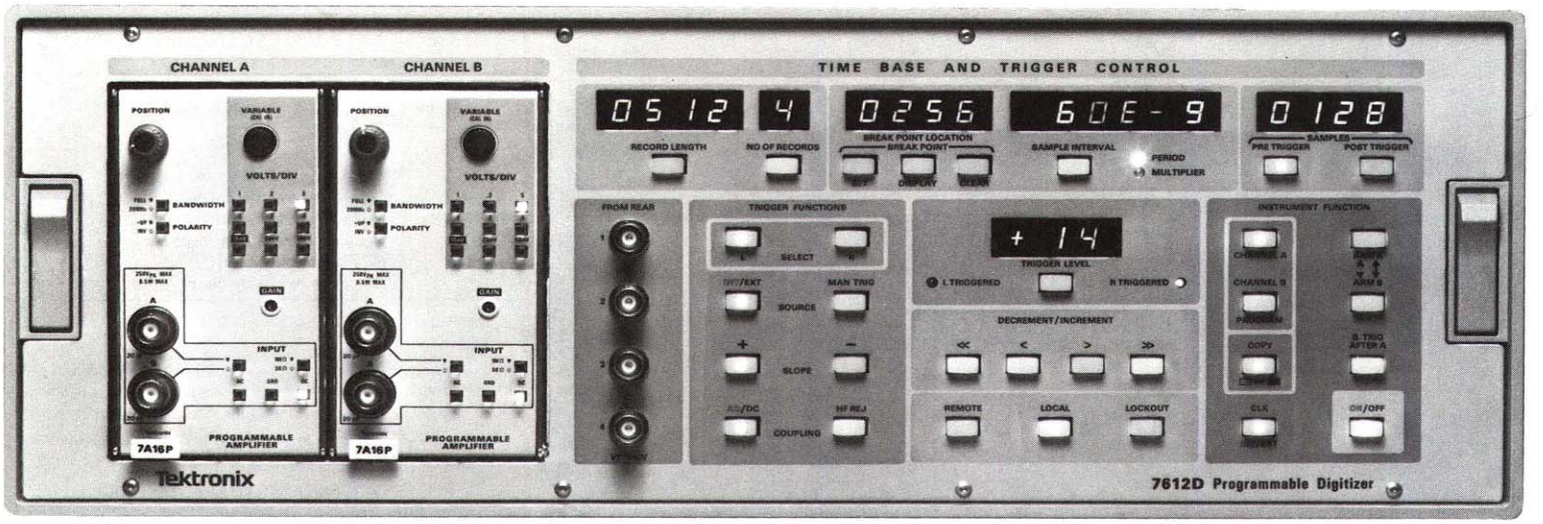
**390AD Service Manual.**

**Probes** — See page 436 for recommended probes.

For floating measurements order A6902A Isolator. See page 434 for complete description.

The 620 monitor is recommended for use with the 390AD. See Alphanumeric Index.

The SONY®/TEKTRONIX® 390AD is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 390AD is available from Tektronix, Inc., its marketing subsidiaries and distributors.




GPIB IEEE-488

## 7612D

The 7612D complies with IEEE Standard 488-1975, and with Tektronix *Standard Codes and Formats*.

**200 MHz Maximum Sampling Rate**

**Two Channels, Two Time Bases**

**8 Bit Resolution**

**2048 Words of Memory per Channel**

**5 ns to 1 s Selectable Sampling Intervals with Interval Switching Allowed During Waveform Acquisition**

**Pretrigger and Posttrigger Operation**

**Fully Programmable Over GPIB for System Oriented Operation**

## TYPICAL APPLICATIONS

- **Automated Testing**
- **EMP**
- **LIDAR**
- **Nondestructive Testing**

The 7612D Programmable Digitizer is a dual-channel, dual time base waveform digitizer for use under computer control. It has a maximum sampling rate of 200 MHz. Each channel has its own analog-to-digital converter, designed by Tektronix for accurate, high-speed waveform digitizing. Each channel also has its own time base operating from a single 200 MHz crystal-controlled clock. The result...two fully independent channels capable of capturing one waveform each, simultaneously, with the same or different vertical sensitivities and time-base settings.

And there's still more flexibility available. The number of samples per waveform (record length) can be selected, from 256 to 2048. The sample rate can be changed during waveform digitizing, for example, using dense sampling on fast transitions and switching to sparser sampling for slow decays. Also, each channel's local memory can be partitioned into one to eight equal-length records. You have the choice, too, of looking at waveforms before the triggering event (pretrigger), immediately after the trigger, or delayed from the trigger (posttrigger). Or you can choose to operate the channels dependently by triggering one after the other.

All 7612D functions can be selected manually or operated under program control over the GPIB. Add two 7A16P Programmable Amplifier plug-ins, one for each channel, and you have program control over every waveform acquisition function.

Extracting information from medium-speed signals is a typical application of 7612D systems.

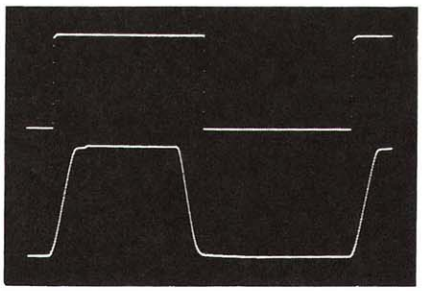


*Figure 1. The complete period of a signal (top trace) is recorded at 200 ns; by changing the sample rate to 10 ns during risetimes and falltimes and 800 ns during the plateau (bottom trace), you can measure risetime, falltime, pulse width and interval accurately on a single-shot signal.*

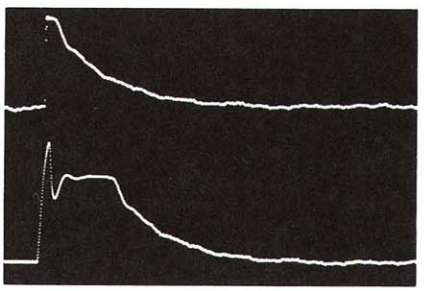


*Figure 2. A decaying signal recorded at a 10 μs sampling rate (top trace); the same signal can be recorded at a 100 ns sampling rate during the initial portion and switched back to a 10 μs sampling rate (bottom trace), to capture all information on a single-shot signal.*

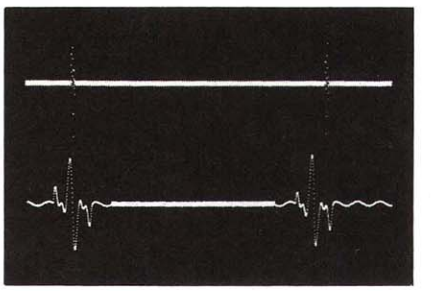


*Figure 3. A signal with two echoes recorded at a uniform sampling rate (top trace), the same signal recorded at an increased sampling rate during each echo (bottom trace), to capture each echo with increased resolution.*

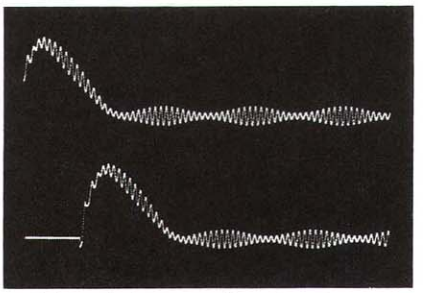


*Figure 4. A transient response of a system at power-up recorded with no pretrigger (top trace); by using the pretrigger the complete response can be digitized (bottom trace).*

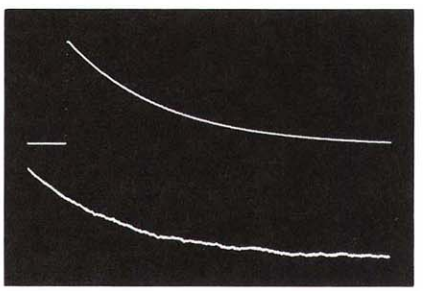
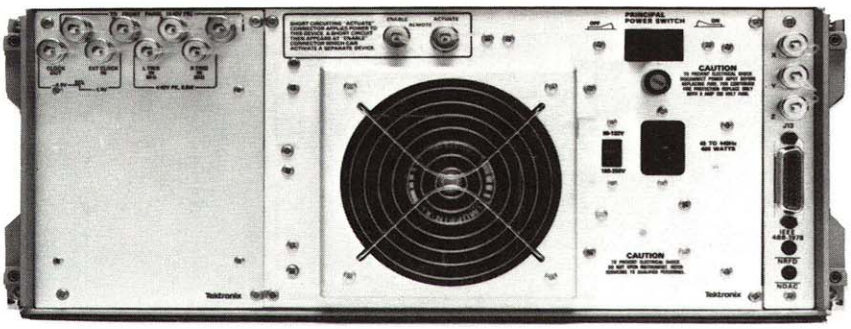


*Figure 5. The initial portion of an exponential decay is recorded on Channel A (top trace); Channel B, set at a higher sensitivity and triggered to record after Channel A has finished, captures the remaining pulse tail with increased vertical resolution (bottom trace).*



*7612D rear panel: the GPIB connector and outputs for an X-Y-Z monitor (right); clock input/output, trigger inputs, and BNC connectors to feed signals to the front panel (left): remote power ON/OFF is also provided through the two central BNC connectors.*

## CHARACTERISTICS

### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments compatible with all 7000 Series amplifier plug-ins. Fully programmable when 7A16P plug-ins are used.
**Bandwidth** — 80 MHz with 7A16P plug-in.
**Modes of Operation** — Left channel with Time Base A and right channel with Time Base B.

### TIME BASES A AND B

**Type** — Two built-in digital time bases with a common crystal-controlled clock.
**Clock** — Internal: 200 MHz ±0.0035%. Stability: Within 10 ppm/year. External: From signal source ≤200 MHz.
**Sample Interval** — With Internal Clock: Selectable from 5 ns to 1 s in a 1, 2, 3...9 sequence (excluding 6, 7, 8 and 9 ns). With External Clock: Selectable from 1 to 200 x $10^6$ times the external clock period in a 1, 2, 4, 6...20 sequence.
**Interval Switching** — Sample interval can be changed up to 13 times/waveform record with preservation of time relationships.
**Time Measurement Accuracy** — 0.0035% (stability 10 ppm/year).
**Modes of Operation** — Time Base A with left channel and Time Base B with right channel. Independent or B triggerable after A completes its acquisition.

### TRIGGERING A AND B

**Source** — Left or right plug-in, external, manual by push button.
**Mode** — Single sweep.
**Coupling** — Ac, dc, ac HF Rej, dc HF Rej.
**Slope** — Positive or negative.
**Level Range** — Internal: At least ±128 LSB in 256 steps. External: At least ±1.28 V in 256 steps.
**Trigger Jitter (Internal)** — 0.1 ns or less, dc to 100 MHz.
**Triggering Error** — ±1 sample ambiguity in recognizing the trigger, 1 sample maximum recognition error between channels (using same trigger channel for both time bases).
**Trigger Sensitivity**

| Coupling | Triggering Frequency Range | Min Signal Required | |
|---|---|---|---|
| | | Internal | External |
| Ac | 40 Hz to 50 MHz | 20 LSB | 100 mV |
| | 50 MHz to 100 MHz | 44 LSB | 100 mV |
| Ac HF Rej | 40 Hz to 50 kHz | 20 LSB | 100 mV |
| Dc | Dc to 50 MHz | 20 LSB | 100 mV |
| | 50 MHz to 100 MHz | 44 LSB | 100 mV |
| Dc HF Rej | Dc to 50 kHz | 20 LSB | 100 mV |

### ARMING A AND B

Push button or computer control.

### DIGITIZING AND STORAGE

**Method** — Continuous, sequential digitizing of the input signals with storage of samples selected by instrument settings.
**Resolution** — Eight bits.
**Dynamic Accuracy**[*1]

| Signal Frequency | S/N Ratio | Effective Bits |
|---|---|---|
| 300 kHz | 42.0 dB | 7.8 |
| 20 MHz | 32.0 dB | 6.0 |
| 80 MHz | 20.0 dB | 4.0 |

*[*1] Signal to noise ratio performance at 25° C for a half scale sinewave input signal (an ideal eight bit digitizer would give a S/N ratio of 43.8 dB). For further information refer to HANDSHAKE VOL 5 NO 1, 33-A-4463.*

**Internal Memory** — Type: ECL. Size: 2048 8-bit/channel, total of 4096 8-bit words.
**Record Length, A or B** — 256, 512, 1024, or 2048 samples. Number of Stored Records: Up to eight 256-word, four 512-word, two 1024-word, or one 2048-word records/channel (each requires a trigger). Trigger is automatically rearmed after each record acquisition.
**Pretrigger Delay Range** — Selectable in multiples of eight samples. Without Sample Interval Switching: From 0 up to 16 samples less than the record length. With Sample Interval Switching: From 0 up to 16 samples less than the position of the first sample interval change.
**Posttrigger Delay Range** — Selectable in multiples of eight samples from eight to the record length (requires selection of only one record).

### OUTPUTS/INPUTS

**X, Y, Z Analog Output** — Provides for analog display of data in memory. X and Y level is 1 V p-p into 100 kΩ or greater; adjustable from 0.75 V to 1.3 V. Z level is 0 to 1 V (full white) into 100 kΩ or greater.
**Clock Out** — Provides internal clock signal at ECL level.
**External Clock In** — ECL levels. ≤1 ns risetime and falltime. 2.5 ns minimum pulse width and ≤200 MHz.
**L and R Trig In** — Provide external trigger input to the left and right trigger channels (50 Ω terminated).
**1, 2, 3, 4** — Four feed-through connections to the front panel.
**Digital Interface** — Conforms to IEEE Standard 488-1975.

### GPIB INTERFACE

**Standard** — Conforms to IEEE Standard 488-1975.
Interface Function Subsets Implemented:

| | |
|---|---|
| SH1 | Complete source handshake |
| AH1 | Complete acceptor handshake |
| TE6 | Extended talker function |
| LE4 | Extended listener function |
| SR1 | Complete service request capability |
| RL1 | Complete remote/local function |
| PP0 | No parallel poll |
| DC1 | Complete device clear capability |
| C0 | No controller function |
| DT0 | No device trigger |

**Response to Interface Control Messages** — The 7612D responds to the following interface control messages:

| | |
|---|---|
| GTL | Go to local |
| LLO | Local lockout |
| SDC-DCL | Selected device clear and device clear |
| SPE-SPD | Serial poll enable and disable |
| IFC | Interface clear |

**GPIB Addresses** — Mainframe and programmable plug-ins share a common primary address and are differentiated through the use of secondary addresses.
**Programmable Functions** — All instrument settings and operating modes are programmable.
**Format** — Commands in ASCII, waveform data in binary (range 0 to $377_8$).
**Transfer Rate** — 710 kbytes/s maximum.
**Waveform Transfer Time** — To an Infinitely Fast Controller: 8.35 ms for one 2048 points record. Actual transfer time depends on controller and software speed.

### ENVIRONMENTAL

**Temperature Range** — Operating: 0°C to +40°C. Nonoperating: −62°C to +85°C.
**Altitude** — Operating: −76 m to +4600 m (−250 ft to +15,000 ft). Nonoperating: −76 m to +15 000 m (−250 ft to +50,000 ft).

### POWER REQUIREMENTS

**Line Voltage Range** — 90 V to 132 V ac, 180 V to 250 V ac.
**Line Frequency** — 48 Hz to 440 Hz.
**Power Consumption (Including Plug-ins)** — Maximum 400 W, 5 A at 115 V 60 Hz.
**Remote Control** — Power On/Off capability is provided.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 483 | 19.0 |
| Height | 178 | 7.0 |
| Depth | 703 | 27.7 |
| **Weights** | **kg** | **lb** |
| Net | 25.0 | 55.0 |

### INCLUDED ACCESSORIES

GPIB cable (012-0630-03); set of rack slides (351-0375-01); power cord (161-0066-00); instruction manual.

# 7A16P

**Fully Programmable Plug-In for 7912AD or 7612D Digitizers Only**

**10 mV/div to 5 V/div Calibrated Deflection Factors**

**200 MHz Bandwidth (7900 Family)**

**50 Ω or 1 MΩ Input Selectable**

The 7A16P is designed for use in Tektronix 7000 Series programmable digitizers. All of the normal operational features of a high-quality, wide-band 7000 Series plug-in amplifier are provided in the 7A16P. These are available at the front panel for manual selection, or they can be set under program control via a programmable mainframe and the GPIB. Whether operated manually or under program control, the front-panel push buttons light to indicate plug-in status. Plug-in status can also be read over the GPIB by an external controller for input to instrument setup and control routines.

Two switch selected input connectors are also provided for selecting input signal source.

## CHARACTERISTICS

**Bandwidth** — Plug-in Only: 225 MHz. With the 7912AD: 200 MHz. Bandwidth may be limited to 20 MHz ±3 MHz by bandwidth limit switch.
**Ac Coupled Lower Bandwidth** — 10 Hz or less.
**Step Response** — 50 Ω input plug-in only, 1.8 ns risetime.
**Deflection Factor** — 10 mV/div to 5 V/div, 9 steps in a 1-2-5 sequence. Accuracy is ±2% of indicated deflection factor with Gain adjusted at 10 mV/div. Uncalibrated Variable is continuous between steps and extends selected deflection factor to at least 2.5 times the calibrated value.
**Input R and C** — Selectable: 1 MΩ within 2% and paralleled by ≈20 pF or 50 Ω ±1 Ω with vswr ≤1.5:1 at 200 MHz or less.
**Inputs** — Selectable A or B signal input connectors.
**Maximum Input Voltage** — 1 MΩ, Dc Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. 1 MΩ, Ac Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. 50 Ω: 0.5 W maximum.
**Programmable Functions** — All functions except Variable, Gain, and Identify are programmable.
**Included Accessory** — Instruction manual.

## ORDERING INFORMATION

**7612D** Programmable Digitizer ..... **$28,075**

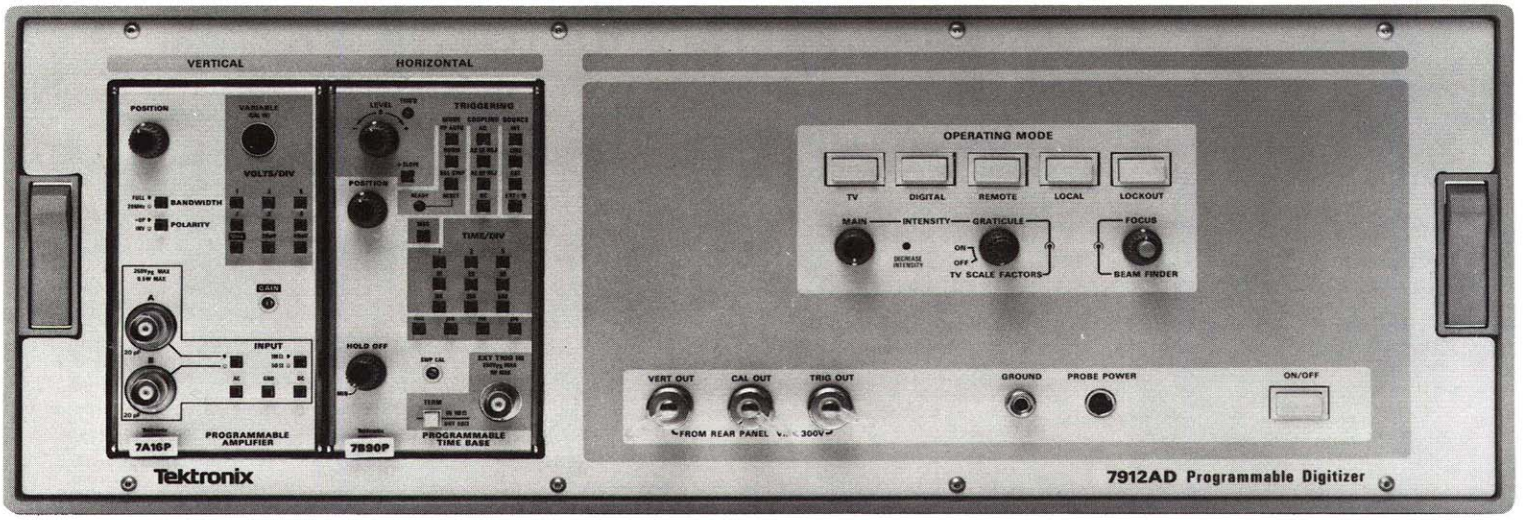
**INTERNATIONAL POWER CORD AND PLUG OPTIONS**
**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

**7A16P** Programmable Amplifier ..... **$2,395**

### SYSTEMS

**The 7612D is also available in MP 1201/MP 2201 Measurement Packages and MS 3201/MS 4201 Acquisition/Processing Measurement Systems. The measurement systems are designed, assembled, tested, and documented to satisfy the demand for speed, automation, accuracy, and repeatability in characterizing devices or phenomena which give rise to waveforms in the second to submicrosecond range. For more information on these systems or packages, contact your local Tektronix Sales Engineer.**

**Tektronix offers service training classes on the 7612D Programmable Waveform Digitizer. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.**




*7912AD shown with the 7A16P and 7B90P programmable plug-ins.*

GPIB IEEE-488

## 7912AD

The 7912AD complies with IEEE Standard 488-1975, and with Tektronix *Standard Codes and Formats*.

**Digitize and Store Single-Shot or Repetitive Signals from Millisecond to Subnanosecond Duration**

**500 MHz Bandwidth at 10 mV/div**

**500 ps/div Fastest Calibrated Sweep Rate**

**Waveform Digitizing to 9-Bit Vertical and 9-Bit Horizontal Resolution**

**Built-In Signal Averaging Capability**

**Fully Programmable Over GPIB For System Oriented Operation**

## TYPICAL APPLICATIONS

- **Destructive Testing**
- **Laser Research**
- **LIDAR**
- **Automated Testing**

Capturing high-speed waveforms is the 7912AD's forte. Each waveform can be sampled up to 512 times within a selectable time window, ranging from ten milliseconds to five nanoseconds (50 kHz to 100 GHz equivalent sampling rate).

This performance is accomplished by a Tektronix scan converter which writes the signal onto a silicon-diode target array. In TV mode, the signal information is read from the target and converted to composite video for a bright display on a television monitor. However, in the Digital mode the waveform data is read into an internal memory. From this memory, the digitized waveform can be transferred via the GPIB to an external controller for processing.

The 7912AD Mainframe is programmable over the same GPIB. When the programable plug-ins (one 7A16P Programmable Amplifier and one 7B90P Programmable Time Base) are used, the 7912AD becomes a fully programmable digitizer with a bandwidth of 200 MHz. This is a significant step toward fully automated test and measurement in disciplines such as laser and energy-related research, component or subassembly testing, and other areas requiring information extraction from high-speed waveforms.

## CHARACTERISTICS

### VERTICAL SYSTEM

**Channels** — Single plug-in compartment accepts any 7000 Series amplifier plug-in. Fully programmable when 7A16P is used.

**Bandwidth (Determined by Amplifier Plug-In)** — 7A16P: 200 MHz. 7A29: 500 MHz.

**Delay Line** — Permits viewing of leading edge of acquired waveform.

### HORIZONTAL SYSTEM

**Channels** — Single plug-in compartment accepts any 7000 Series time base. Fully programmable with 7B90P.

**Fastest Calibrated Sweep Rate** — 500 ps/div with the 7B90P or 7B92A Time Bases.

**Slowest Recommended Sweep Rate** — 1 ms/div in Digital mode.

### DIGITIZING AND STORAGE

**Method** — Scan conversion.

**Resolution** — Nine bits. In the Digital mode, the target is scanned in a 512 x 512 point matrix offering at least 400 discrete horizontal elements, each with a range of at least 320 discrete vertical values. In the TV mode, the target is scanned in a standard TV format with a resolution of at least 400 lines at 50% response.

**Writing Rate (+10°C to +40°C)** — TV Mode: Writes an 8 div sinewave of at least 500 MHz in a single sweep. Digital Mode: Stores a single 8 div pulse with a risetime of 1 ns or less.

**Target Defects** — No more than six points digitized other than those written by input waveform. Built-in firmware allows for defect removal by an external controller.

**Memory** — Type: Semiconductor. Size: 4096 10-bit words for data from target and two 512 16-bit word areas for internally processed and reduced data. Record Length: 512 samples/waveform maximum.

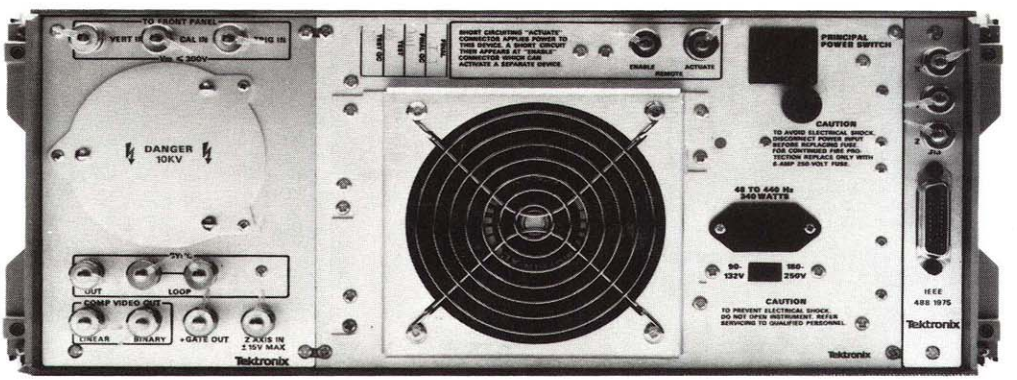
### ELECTRONIC GRATICULE

8 x 10 div dot matrix written onto the scan converter target immediately after waveform acquisition. Can be displayed simultaneously with the input signal on the TV monitor or digitized and stored.

### OUTPUTS/INPUTS

**X, Y, Z Analog Output** — Provides for analog display of data in memory. X and Y level is 1 V p-p into 100 kΩ or greater; adjustable from 0.75 V to 1.3 V. Z level is 0 V to 1 V (full white) into 100 kΩ or greater.

**Composite Video Output** — Only available in TV mode. Used to drive a TV monitor for displaying signal written on scan-converter target as an aid to setting intensity for complete digitizing. Linear Output: Replica of the signal read from the target with sync added. Binary Output: Two-level output derived from the linear composite video output. Used to indicate on the TV monitor how well a waveform will be digitized. Scale factor readout included in both linear and binary.



**Sync Output** — At least 4 V into 75 Ω. Conforms to EIA RS-170.

**Sync Loop** — Allows TV mode to be synchronized with external EIA RS-170 sync waveform.

**+Gate Output** — Provides a positive pulse with a duration equal to and coincident with the time base sweep.

**Z-Axis Input** — ±1 V input modulates the writing gun intensity over its full range.

**Vert In, Cal In, Trig In** — Three internal 50 Ω coaxial cables connect signals from the rear panel to the front panel to ease system configuration in rackmounts.

**Probe Power** — Provides power for Tektronix active probes.

### GPIB INTERFACE

**Standard** — Conforms to IEEE Standard 488-1975.

Interface Function Subsets Implemented:

| | |
|---|---|
| SH1 | Complete source handshake |
| AH1 | Complete acceptor handshake |
| TE6 | Extended talker function |
| LE4 | Extended listener function |
| SR1 | Complete service request capability |
| RL1 | Complete remote/local function |
| PP0 | No parallel poll |
| DC1 | Complete device clear capability |
| C0 | No controller function |
| DT1 | Device trigger complete |

### ENVIRONMENTAL

**Temperature Range** — Operating: 0°C to +40°C. Nonoperating: −55°C to +75°C.

**Altitude** — Operating: Up to 4600 m (15,000 ft). Nonoperating: Up to 15 000 m (50,000 ft).

**EMC (plug-ins inserted)** — Meets MIL-STD-461A and 462 radiated and conducted interference from 30 Hz to 1 GHz.

### POWER REQUIREMENTS

**Line Voltage Range** — 90 V to 132 V ac and 180 V to 250 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Power Consumption (Including Plug-ins)** — 360 W maximum.

**Remote Control** — Remote power On/Off capabilities provided.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 483 | 19.0 |
| Height | 178 | 7.0 |
| Length | 679 | 26.8 |
| **Weight** | **kg** | **lb** |
| Net | 24.7 | 54.6 |

### INCLUDED ACCESSORIES

Power cord (161-0066-00); set of rack slides (351-0375-01); GPIB cables (012-0630-03); instruction manual.

## 7A16P

**Fully Programmable Plug-in for 7912AD or 7612D Digitizers Only**

**10 mV/div to 5 V/div Calibrated Deflection Factors**

**200 MHz Bandwidth (7900 Family)**

**50 Ω or 1 MΩ Input Selectable**

The 7A16P is designed for use in Tektronix 7000 Series programmable digitizers. All of the normal operational features of a high-quality, wide-band 7000 Series plug-in amplifier are provided in the 7A16P. These are available at the front panel for manual selection, or they can be set under program control via a programmable mainframe and the GPIB.

Whether operated manually or under program control, the front-panel push buttons light to indicate plug-in status. Plug-in status can also be read over the GPIB by an external controller for input to instrument setup and control routines.

Two switch selected input connectors are also provided for selecting input signal source.

### CHARACTERISTICS

**Bandwidth** — Plug-in Only: 225 MHz. With the 7912AD: 200 MHz. Bandwidth may be limited to 20 MHz ±3 MHz by bandwidth limit switch.

**Ac Coupled Lower Bandwidth** — 10 Hz or less.

**Step Response** — 50 Ω input plug-in only, 1.8 ns risetime.

**Deflection Factor** — 10 mV/div to 5 V/div, 9 steps in a 1-2-5 sequence. Accuracy is ±2% of indicated deflection factor with Gain adjusted at 10 mV/div. Uncalibrated variable is continuous between steps and extends selected deflection factor to at least 2.5 times the calibrated value.

**Input R and C** — Selectable: 1 MΩ within 2% and paralleled by ≈20 pF or 50 Ω ±1 Ω with vswr ≤1.5:1 at 200 MHz or less.

**Inputs** — Selectable A or B signal input connectors.

**Maximum Input Voltage** — 1 MΩ, Dc Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. 1 MΩ, Ac Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. 50 Ω: 0.5 W maximum.

**Programmable Functions** — All functions except Variable, Gain, and Identify are programmable.

**Included Accessory** — Instruction manual.

## 7B90P

**500 ps/div to 500 ms/div Calibrated Time Base**

**Fully Programmable Plug-in 7912AD Digitizer Only**

**400 MHz Trigger Bandwidth**

**Single-Sweep Operation**

The programmable 7B90P is designed for use with a Tektronix 7912AD Programmable Digitizer. Its operating functions can be manually selected at the front panel or selected under program control via the GPIB. The only nonprogrammable functions are the Sweep Calibration adjustment and the External Trigger Input Terminator Switch.

### CHARACTERISTICS

**Sweep Rates** — 500 ms/div to 10 ns/div in 24 steps. Magnifier extends fastest calibrated sweep rate to 500 ps/div.

**Sweep Accuracy** — Measured over center 8 div, +15°C to +35°C, with any 7000 Series programmable mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

| Time/Div | Unmagnified | Magnified |
|---|---|---|
| 500 ms/div to 100 ns/div | 2% | 3% |
| 50 ns/div to 10 ns/div | 3% | 4% |
| 500 ps/div | — | 5% |

**Trigger Holdoff** — Programmable in 62 steps between minimum and maximum.

| Time/Div | Min (ccw) | Max (cw) |
|---|---|---|
| 500 ps/div to 2 μs/div | ≤3.5 μs | ≥90 μs |
| 5 μs/div to 20 μs/div | ≤35 μs | ≥900 μs |
| 50 μs/div to 200 μs/div | ≤350 μs | ≥9 ms |
| 500 μs/div to 2 ms/div | ≤3.5 ms | ≥90 ms |
| 5 ms/div to 500 ms/div | ≤35 ms | ≥900 ms |

**Triggering Sensitivity**

**P-P AUTO MODE**

| Triggering Frequency Range | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|
| At least 50 Hz | 2.0 div | 500 mV |
| 200 Hz to 50 MHz | 0.5 div | 125 mV |
| 50 MHz to 400 MHz | 1.5 div | 375 mV |

**NORM MODE**

| Coupling | Triggering Frequency Range | Min Signal Required Int | Min Signal Required Ext*1 |
|---|---|---|---|
| Ac | 30 Hz to 50 MHz<br>50 MHz to 400 MHz | 0.3 div<br>1.5 div | 100 mV<br>250 mV |
| Ac LF Rej*2 | 30 kHz to 50 MHz<br>50 MHz to 400 MHz | 0.3 div<br>1.5 div | 100 mV<br>250 mV |
| Ac HF Rej*3 | 30 Hz to 50 kHz | 0.3 div | 100 mV |
| Dc | Dc to 50 MHz<br>50 MHz to 400 MHz | 0.3 div<br>1.5 div | 100 mV<br>250 mV |

*1 *Ext ÷ 10 operation attenuates ext trigger signal 10 times.*
*2 *Will not trigger on sinewaves or <8 div Internal, or 3 V External, at or below 60 Hz.*
*3 *Will not trigger on 50 MHz sinewaves 1.5 div or less Internal, or 0.15 V or less External.*

**Single-Sweep Mode** — Same as Norm mode.

**Trigger Level** — Programmable in 0.05 div steps.

**Horizontal Position** — Programmable in 0.0125 div step unmagnified, 0.125 div step magnified.

**Internal Trigger Jitter** — 0.1 ns or less at 400 MHz.

**External Trigger Input** — Selectable: 1 MΩ ±5%, 20 pF ±10% or 50 Ω ±5% with 1.22 maximum vswr at 400 MHz. Maximum input is 250 V (dc + peak ac) for 1 MΩ or 1 W for 50 Ω. The level range (excluding p-p Auto) for a 1 kHz sinewave input is at least ±3 V in Ext and at least ±30 V in Ext ÷ 10.

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**(PLUG-INS NOT INCLUDED)**

It is recommended that 7912ADs not be purchased or operated without an accompanying Tektronix 634 Raster Scan Display Monitor (see page 82).

**7912AD** Programmable Digitizer ..... **$27,025**

**Option 13** — Change TV Scan to 625 lines at 50 Hz ..... **NC**

**Option 30** — Delete GPIB Cable ..... **−$90**

**634** Raster Scan Display Monitor ..... **$3,500**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

**7A16P** Programmable Amplifier ..... **$2,395**

**7B90P** Programmable Time Base ..... **$2,885**

### SYSTEMS

**The 7912AD is also available in the MP 1101/MP 2101 Measurement Packages and the MS 3101/MS 4101 Acquisition-/Processing Measurement Systems. The measurement systems are designed, assembled, tested, and documented to satisfy the demand for speed, automation, accuracy, and repeatability in characterizing devices or phenomena which give rise to waveforms in the millisecond to nanosecond range. For more information on these systems and packages contact your local Tektronix Sales Engineer.**

**Tektronix offers service training classes on the 7912AD Programmable Transient Waveform Digitizer. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.**

GPIB IEEE-488

# 5223

The 5223 Option 10 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**Digital Storage (with 5B25N)**

**10 MHz Bandwidth Repetitive Store (Up To 1 GHz with a Sampling Plug-In)**

**100 kHz Bandwidth Single Shot Store**

**Pretrigger**

**10 Bit Vertical Resolution**

**Stored X Versus Y Display**

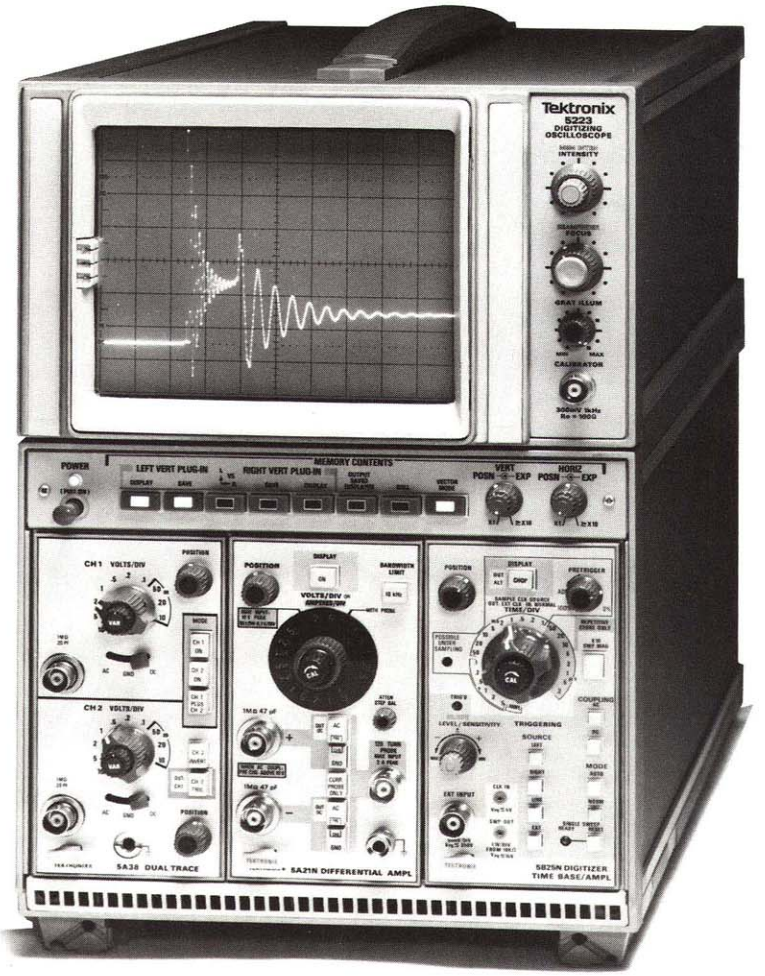
**Roll Mode**

**X-Y Plotter Output with Penlift**

## TYPICAL APPLICATIONS

* **Mechanical Transducers**
* **Biophysical**
* **GPIB**

The Tektronix 5223 Digitizing Oscilloscope is a digital storage instrument with a real-time bandwidth of 10 MHz. The 5223 is capable of displaying real-time and stored waveforms simultaneously (four real-time waveforms and four stored waveforms, if dual channel amplifier units are used); the real-time waveforms need not be related to the stored waveforms. Stored waveforms can be expanded vertically and horizontally up to a factor of ten, using front-panel controls. The left and right stored vertical signals can be displayed against each other in the X-Y mode, using the L vs R front-panel display function. The roll mode is useful when viewing low frequency signals. Rear-panel connectors provide access to the internal analog and control signals to record stored waveforms using associated equipment (e.g., X-Y plotter). The 5223 accepts most 5000 Series plug-in units; the flexibility of the plug-in feature, and variety of plug-in units available, allows the system to be used for many measurement applications. The digital storage functions can only be accessed or enabled by using the 5B25N Time Base.




### Display and Save Functions

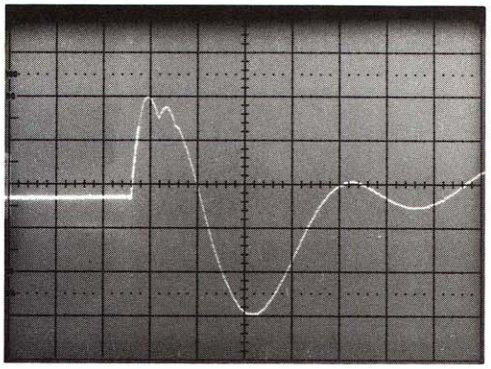
The Display buttons allow the 5223 to digitize the signals originating from the corresponding vertical compartments (left and right). The digitized display is continuously updated as long as a triggered sweep occurs, or until the Save button is pushed. The Save buttons freeze the memory contents. Up to four channels may be displayed and saved simultaneously.

### L vs R Display

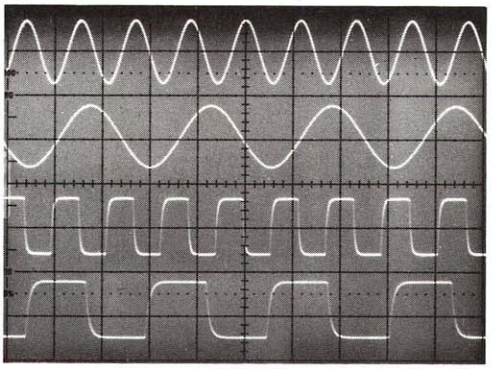
This function will display the memory contents of the left compartment versus the right compartment. The left defines the vertical axis and the right compartment defines the horizontal axis. Since the X-Y display is from memory, the real-time sweep is still in the standard Y-time format and may be displayed simultaneously.

### Roll Mode Display

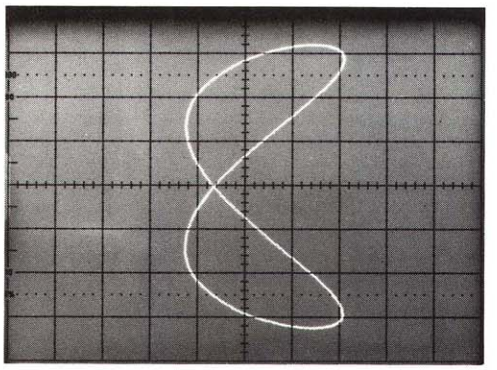
For continuous data stream monitoring of biomedical or low frequency events, the Roll mode digitizes the signal and displays the latest acquired point at the right of the CRT while the previous data moves from right to left. The display appears much like a strip chart recorder. Roll mode is available on the sweep range of 5 s/div to 0.1 s/div.



*Single-shot data can be captured and stored automatically without the operator's presence. Pretrigger signal portion has an intensified trace for easy reference.*



*Up to four channels may be stored at a time either Single Shot or Repetitive.*



*By pressing the L vs R button, the memory contents of one vertical compartment are displayed against that of the other.*

### Vector Display
When Vector Display is selected, a continuous trace connects the discrete data points into a clear and comprehensive display. This eliminates perception problems of scattered data and reduces interpretation errors.

### Output Saved Displays
When pressed, an analog output of the displayed/saved waveforms is activated for driving conventional X-Y analog plotters. Pen lift is also provided and is activated before and after each waveform is output. Up to four waveforms may be output.

### Display Out Speed Control (Rear Panel)
The Display Out Speed control adjusts the X-Y plotter output speed to compensate for differences in plotter speeds and response.

## CHARACTERISTICS

#### VERTICAL REAL TIME SYSTEM

**Channels** — Two plug-in compartments; compatible with 5000 Series plug-ins.

**Mainframe Bandwidth** — 10 MHz with 5A38, 5A45 or 5A48.

**Mainframe Step Response** — 35 ns.

**Chop Mode** — 100 chopped segments/div unexpanded with 5B25N Time Base.

**Delay Line** — Permits viewing leading edge of displayed waveform.

#### HORIZONTAL REAL TIME SYSTEM

**Channel** — Single compartment compatible with 5000 Series time bases and amplifiers. 5B25N must be used in storage modes.

**Fastest Calibrated Sweep Rate** — 20 ns/div.

**X-Y Mode** — <2° phase shift, dc to 20 kHz between either vertical compartment and horizontal compartment.

#### DIGITAL STORAGE (with 5B25N)

**Vertical Resolution** — 10 bits (100 pts/div unexpanded).

**Display Memory Size** — 1 k points/vertical compartment, shared by multiple trace plug-ins.

**Sample Rate** — Maximum of 1 μs/pt (1 MS/s). Actual sample rate depends on time base setting.

**Fastest Single Shot Sweep Speed** — 100 μs/div.

**External Clock In** — Maximum of 1 MS/s (1 μs/pt). TTL compatible.

**Equivalent Time Bandwidth** — 10 MHz.

**Acquisition Window** — ±4 div vertically and ±5 div horizontally from center screen.

**Accuracy** — Determined by plug-ins. Refer to plug-in specifications.

**X-Y** — (Left vs right single channel mode only excluding 100 μs/div sweep range). Maximum of 5° phase shift between vertical compartments up to 10 MHz using two identical 5400 Series vertical plug-ins.

#### MEMORY CONTROLS

**Display and Save** — Controls for each vertical compartment. X-Y (left vs right), Data Out, Roll, Vector mode, Horizontal and Vertical positioning, and expansion (≥10:1).

**Data Out** — Analog voltage of stored signal. 200 mV/div ±5%. Output rate variable with rear panel control. Pen lift available on rear panel (normally open).

#### OUTPUT/INPUTS

**Plug-in Signal Outputs** — Left, Right Vertical, Horizontal Compartments: 50 mV/div ±5% from 50 Ω. Left, Right Vertical Compartments: Dc ≥10 MHz. Horizontal Compartment: Dc ≥7 MHz.

**Time Base Gate** — TTL compatible, positive going.

**Remote Single Sweep Reset** — Rear panel BNC closure to ground resets sweep.

**External Z-Axis Input** — Usable, dc ≥5 MHz voltage swing of 5 V will fully modulate beam dc ≥1 MHz. Negative voltage will blank trace. Maximum input voltage is 40 V (dc + peak ac).

**Calibrator** — Voltage Output: Squarewave, positive going from ground. Amplitude is 300 mV ±1%. Current Output: 3 mA ±1% available through calibrator output with optional BNC to current loop adaptor.

#### CRT AND DISPLAY FEATURES

**CRT** — 8 x 10 div with 1.22 cm/div. Internal illuminated graticule.

**Phosphor** — GH (P31) standard.

**Acceleration Potential** — 15 kV.

**Camera Power** — Compatible with Tektronix C-59 Camera.

#### POWER REQUIREMENTS

**Line Voltage Range** — 90 v to 117 V, 102 v to 132 V, 191 V to 249 V, 204 V to 250 V maximum.

**Line Frequency** — 48 Hz to 62 Hz (48 Hz to 440 Hz, Option 05).

**Maximum Power Consumption** — 145 W at 120 V, 60 Hz.

#### OPTIONS

**Option 05 Line Frequency Change (48 Hz to 440 Hz)** — Converts the R5223 to 48 Hz to 440 Hz operation.

**Option 10 GPIB Interface** — For I/O of stored waveforms and control of 5223 digital storage functions (except vertical and horizontal expansion and position controls). Waveform output format is selectable through the interface for BINARY or ASCII.

The Tektronix 4932 GPIB Extender provides a cost-effective way to interconnect remotely located GPIB instruments, allowing communication at distances of up to 500 meters (1650 feet).

**I/O Records** — Waveforms.

**Device Address** — Selectable via rear panel switch.

**Talk/Listen** — Full bi-direction transfer of waveforms plus remote manipulation of storage controls.

**Talk Only** — Continuous output of digitized waveform to maximum sweep of 20 ms/div (dependent on other instruments on bus).

**Interface Function Subsets Implemented:**

| | |
|---|---|
| SH1 | Complete source handshake |
| AH1 | Complete acceptor handshake |
| T5 | Talker function |
| L4 | Listener function |
| SR1 | Complete service request capability |
| RL2 | Remote/local capability |
| DC1 | Complete device clear capability |

#### PLUG-IN COMPATIBILITY

All 5000 Series plug-ins are compatible in the standard oscilloscope display mode. The 5L4N, 5A18N, 5A26, 5A48 plug-ins may require modification for optimum use with digital storage operation. The 5A14N is not recommended for use in storage mode.

**Included Accessory** — Instruction manual.

**Dimensions and Weights** — See page 275.

# 5B25N Digital Time Base

**Bi-Slope Triggering**

**20 ns/div to 5 s/div Calibrated Time Base**

**Triggering to 15 MHz**

The 5B25N is designed specifically for use in the 5223 Digital Storage Oscilloscope. Pretrigger is only available with the 5223. However, the standard analog sweep features including Bi-Slope Triggering and X10 Mag are compatible with 5400 Series mainframes.

## CHARACTERISTICS

**Modes** — Auto, Normal, Single Sweep.

**Single Sweep** — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep.

**External Trigger Input** — Maximum input voltage is 350 V-peak. Input R and C is 1 MΩ paralleled by ≈24 pF.

**External Horizontal Input** — Deflection factor is 50 mV/div ±3%. Dc coupled bandwidth is dc to 2 MHz.

**Sweep Rate** — 0.2 μs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 20 ns/div is fastest sweep rate obtained with X10 magnifier. Uncalibrated, continuously variable between steps and up to 12.5 s/div.

#### TRIGGERING

| Slope | Frequency Range | Minimum Signal Required: Internal | Minimum Signal Required: External |
|---|---|---|---|
| + or − | Dc to 1 MHz<br>1 MHz to 15 MHz | 0.4 div<br>0.6 div | 50 mV<br>200 mV |
| ± (Bi-Slope) | Dc*1 to 1 MHz | ±0.5 div | ±50 mV |

**1 30 Hz when ac coupled.*

**Bislope Triggering** — Will trigger on either a positive or negative slope and the threshold or sensitivity is controlled by the trigger level knob. This eliminates the uncertainty of which slope is selected.

## CHARACTERISTICS
### (WHEN USED WITH THE 5223 MAINFRAME)

**Accuracy**

| Time/Div | Sweep*1 | Digitized*2 | Digitized to Real Time*3 |
|---|---|---|---|
| 50 μs/div to 0.2 μs/div | 3% | 3% | 3% |
| 1 s/div to 0.1 ms/div | 3% | 3% | 3% |
| 2 s/div and 5 s/div | 4% | 3% | 4% |

**1 Accuracy is specified over the center 8 graticule divisions, in 5223 or 5400 Series oscilloscopes. Derate accuracy by 1% for 0° C to +50° C, or when using X10 magnifier.*

**2 Digitized signal accuracy is specified over center 8 graticule divisions in 5223 Oscilloscope, excluding first 200 ns or 0.2 div of each waveform.*

**3 The digitized signal will match the real time signal within the specified tolerance.*

**Pretrigger** — For viewing events that occur prior to the trigger and is continuously variable from 0% to 100% of full screen. An intensified zone is generated which corresponds to the amount of pretrigger selected. This intensified zone remains with the saved waveform. Pretrigger is available from 5 s/div to 0.1 ms/div.

**Possible Undersampling Indicator** — To aid in eliminating aliasing, an LED indicator illuminates when the ratio of sampling frequency to trigger frequency is less than eight.

**Sampling Rate** — For single shot acquisition, the 5B25N has a maximum sample rate of 1 MHz at 0.1 ms/div.

**Repetitive Store** — For repetitive signals, the 5B25N controls the equivalent time sampling feature of the 5223 to allow digitizing from 50 μs/div to 0.2 μs/div.

**External Clock Input** — Clock-In pin jack allows the user to introduce an external sampling clock. Maximum input frequency of 1 MHz, with TTL threshold, and 5 V peak input voltage.

**Included Accessory** — Instruction manual.

## ORDERING INFORMATION

**5223** Digitizing Oscilloscope ..... **$5,390**

**R5223** Rackmount ..... **$5,545**

**Option 05** — Line Freq Change (R5223 Only) ..... **+$200**

**Option 10** — GPIB Interface ..... **+$750**

#### CONVERSION KITS

**Rackmount-to-Cabinet** — Order 040-0975-01 ..... **$275**

**Cabinet-to-Rackmount** — Order 040-0976-04 ..... **$375**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

**Option A5** — Switzerland 220 V/10 A, 50 Hz

**5B25N** Time Base ..... **$905**

#### OPTIONAL ACCESSORIES

**Recommended Cart** — The Model 3 Scope-Mobile® Cart is recommended for all 5000 Series oscilloscopes. A storage area for plug-ins is available upon request. Contact your local Tektronix representative for price and delivery.

Refer to page 455 for mechanical transducers.

NEW

# ACQUISITION/PROCESSING SYSTEMS

## CONTENTS

System Products ..... 346
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*MP 2501 Desktop Controller-Based 7854 System*

*MS 4101 Computer - Based 7912AD System*

**Precise automatic waveform measurements for demanding applications in research, design, manufacturing and quality assurance**

**Automatically save hours, days, even months of work**

Tektronix measurement systems are specially designed to handle the increasingly complex, expensive, and time-consuming task of waveform characterization.

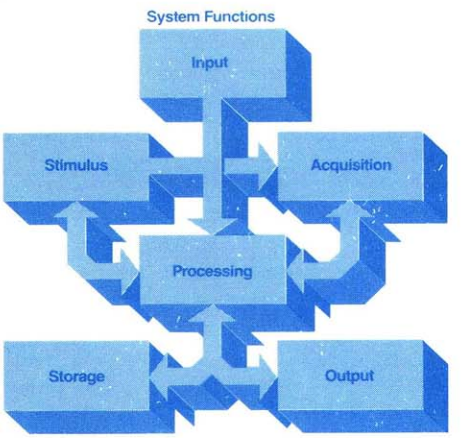
They're the first measurement systems to offer all the power and flexibility of oscilloscope acquisition, which may be coupled with programmable stimulus sources for fully automatic analysis. They're the first systems to feature signal processing software with extensive control over instrumentation, waveform manipulations, and graphic display. And they're the first to provide system compatibility that allows configuration for many types of test and measurement applications.

From today's research and development tasks to tomorrow's production testing, Tek systems give you all the capabilities needed to characterize your waveforms quickly, efficiently, and accurately.

**Systems that put you in charge.**

**System Building Blocks**

No matter whether your application is in scientific research, engineering design or automated manufacturing and quality control, Tektronix provides for each of the functions that comprise virtually every measurement system.



NEW

Functional compatibility among Tek system components gives you the flexibility of selecting specialized instruments, integrating them easily and broadening the application potential of your automated testing unit as your requirements grow.

**Save Hours, Days, Even Months of Work**
Tek measurement systems combine state-of-the-art waveform acquisition capabilities with computer processing and software control. They automatically capture the signals you need, make the measurements you want, then display, store and document your results. Projects are more likely to be completed on time and within budget. We provide each of the major functions that comprise a measurement system.

**Input Devices**
Keyboards and keypads on terminals, controllers and some instruments provide convenient access to the system.

**Acquisition**
Tek's growing family of GPIB-compatible waveform digitizers offers the ability to capture signals ranging from seconds to picoseconds in duration, with bandwidths up to 14 GHz. Plus, compatibility with a broad range of 7000 Series plug-ins provides an added dimension of measurement flexibility.

**Stimulus**
Stimulus units, including function generators, signal generators and other sources, provide known control signals to drive the device under test through normal operation patterns or into boundary conditions for performance limits testing.

**Processing**
Tek minicomputer systems built around the DEC MICRO/PDP-11*[1] are designed to handle larger amounts of data and offer considerable flexibility in peripheral selection, processing power and speed, software modularity and extended memory. Systems built around the Tek 4041 feature benchtop convenience with powerful analytical and instrument control capabilities.

**Mass Storage**
In the form of disk or magnetic tape, mass storage provides permanent storage of raw or processed data for later retrieval, and can also be used to store the test programs.

**Output Devices**
Graphics terminal and hard copy units provide alphanumeric and graphic presentation of data and programs as well as permanent documentation. Because the quality of the solution is often dependent on the quality of the display, you gain additional advantage by Tek's leadership in high-resolution, reliable graphic and alphanumeric displays.

**Software**
Tektronix minicomputer controllers can be operated with TEK SPS BASIC, a powerful general purpose programming language which offers convenient control of instruments to acquire, process, store and display waveform data with ease. TEK SPS BASIC combines the advantages of being an interactive language with the high performance of a computer operating system. The Tek 4041 comes with its own version of extended BASIC...providing both the simplicity desired by the beginner and the flexibility and power required by the experienced programmer.

For a complete description and ordering information on SPS BASIC, see pages 327-328.

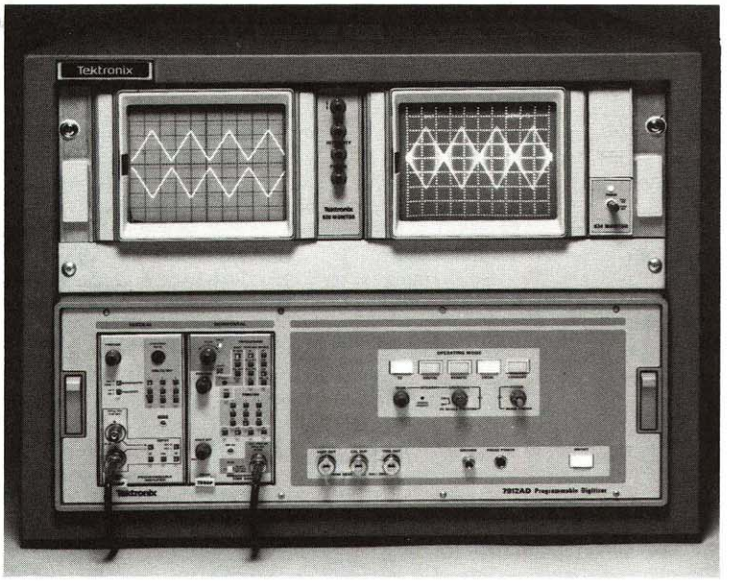
**The Choice is Yours**
Tektronix offers both factory-integrated measurement systems (MS) and preconfigured measurement packages (MP), the latter which you integrate and install yourself. Individual system configurations are summarized in the chart below. They have been selected to provide a high level of performance and permit maximum flexibility...systems that put you in charge.

*[1] DEC and PDP are registered trademarks of Digital Equipment Corporation.*

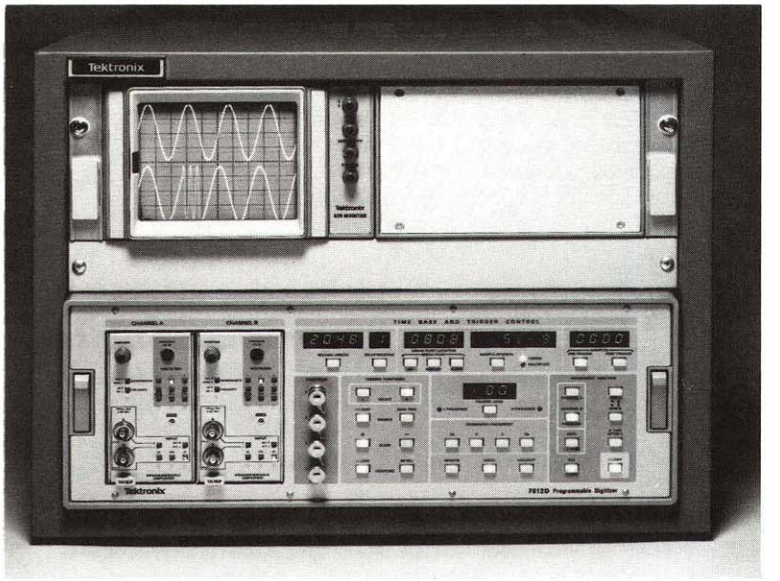
**INDIVIDUAL SYSTEM CONFIGURATION**

| **Application** | Fastest Single-shot transient digitizer, at highest bandwidth | High bandwidth, multi-record, dual-channel digitizer for both single-shot and repetitive signals | Compact dual-channel signal acquisition, for medium bandwidth repetitive and single-shot signals | Excellent signal acquisition for repetitive signals, high bandwidth | Versatile and compact signal stimulus and acquisition for medium and low speed signals |
|---|---|---|---|---|---|
| **Acquisition Instrument** | **7912AD** | **7612D** | **7D20T** | **7854** | **MI 5010/MX 5010** |
| **Controller** | | | | | |
| **Your own** | **MP 1101** | **MP1201** | | | |
| **Compact** Tektronix 4041 with enhanced instrument control and analysis BASIC software | **MP 2101** | **MP 2201** | **MP 2401** | **MP 2501** | **MP 2901** |
| **Expandable** MICRO/PDP-11 with TEK SPS BASIC control and analysis software | **MS 3101** | **MS 3201** | — — | — — | — — |
| **Fast** CP1164X with TEK SPS BASIC control and analysis software | **MS 4101** | **MS 4201** | — — | — — | — — |

NEW




*MP 1101*




*MP 1201*

## GPIB IEEE-488 MP 1101/MP 1201

The MP 1101 and MP 1201 comply with IEEE Standard 488-1975.

**MP 1101 Features:**

**Highest Bandwidth Single-Shot Acquisition (up to 500 MHz at 10 mV/Div, Nonprogrammable)**

**Fully Programmable up to 200 MHz Bandwidth**

**Codes and Formats Features**

**MP 1201 Features:**

**Dual-Channel Signal Acquisition (up to 200 MS/s Sampling Speed). Signal Bandwidth of 80 MHz**

**Record Length of 2048 Words Each Channel**

**Selectable Record Length from 256 Words to 2048 Words Each Channel**

**Codes and Formats Features**

The MP 1101 is based on the high-bandwidth 7912AD Programmable Transient Digitizer. It is excellent for any signal measurement requirement needing single-shot acquisition (either for computer or operator interpretation of extremely fast signals such as laser-research and high-energy physics phenomena).

Without a controller, the MP 1101 may be used as a high bandwidth storage oscilloscope.

The MP 1101 Programmable Digitizer Measurement Package includes 7912AD Programmable Transient Waveform Digitizer, 7A16P Programmable Amplifier, 7B90P Programmable Time Base, 620 General Purpose X-Y Monitor, 634 High Resolution Video Monitor, mounting hardware cables and accessories, and cabinet (shipped unassembled).

The MP 1201 is based on the 7612D Dual Channel Programmable Waveform Digitizer. It features very flexible record partitioning during acquisition, allowing up to 13 changes in sampling rate per record for optimum signal resolution and best memory utilization.

The MP 1201 Programmable Digitizer Measurement Package includes 7612D dual channel Programmable Waveform Digitizer, two 7A16P Programmable Amplifiers, 620 General Purpose X-Y Monitor, mounting hardware, cables and accessories.

### CHARACTERISTICS

The following characteristics are the same for the MP 1101 and MP 1201 unless otherwise indicated.

#### ENVIRONMENTAL CHARACTERISTICS

**Operating Temperature** — 0°C to +40°C (+32°F to +104°F).

**Thermal Output** — Approximately 1550 BTU/hr.

**Operating Altitude** — 4600 m maximum (15,000 ft)

#### PHYSICAL CHARACTERISTICS

| Cabinet Dimensions | mm | in |
|---|---|---|
| Height | 419 | 16.5 |
| Width | 537 | 21.1 |
| Depth | 813 | 32.0 |

#### POWER REQUIREMENTS

**Standard Operating Voltage** — 115 V (nominal).

**Line Frequency** — 60 Hz.

**Maximum Power Consumption** — 450 W (nominal).

### ORDERING INFORMATION

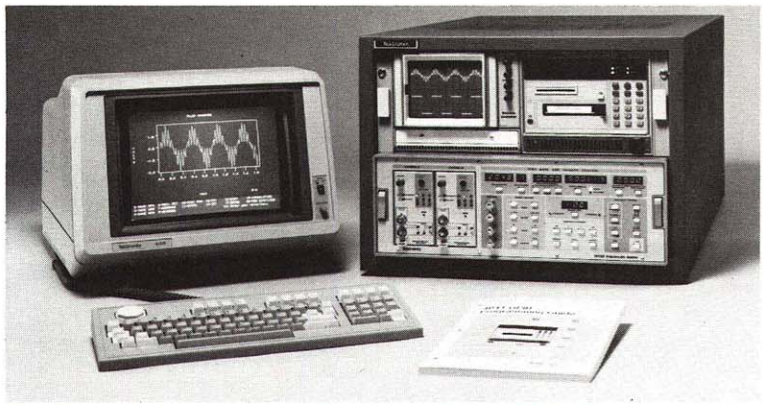
**MP 1101** Programmable Digitizer Measurement Package ..... **$38,795**

**Option 01** — Delete Plug-ins ..... **$5,280**

**MP 1201** Programmable Digitizer Measurement Package ..... **$35,830**

**Option 01** — Delete Plug-ins ..... **$4,790**

**For additional information on alternate mounting configurations contact your local Tektronix Sales Office and ask for a Sales Engineer.**



*The MP 2201 Measurement Package (shown above) consists of 4105, 4041, plus MP 1201 Measurement Package (described on page 348). The MP 2101 Measurement Package (not shown) replaces the MP 1201 with the MP 1101 (described on page 348).*

*The MP 2401 Measurement Package consists of a display monitor, 7D20T, 4041, and 4105.*

GPIB
IEEE-488

The MP 2101/MP 2201/MP 2401 comply with IEEE Standard 488-1975. The MP 2401 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats*.

## MP 2101/MP 2201/MP 2401

**High-Performance Waveform Acquisition**

**Fully Programmable over IEEE Standard 488 Bus for System Oriented Operation**

**Enhanced BASIC Language—Resident 4041 BASIC with Numerous Extensions**

**MP 2101 Features:**

**Ultra High-Speed Single Shot Digital Storage Capability**

**Up to 200 MHz Bandwidth at 10 mV/Div and Full Programmablility with 7A16P Vertical Plug-in**

**Up to 500 MHz Bandwidth at 10 mV/Div with 7A19 Vertical Plug-in**

**Codes and Formats Features**

**MP 2201 Features:**

**200 Megasamples Per Second Maximum Rate, Each Channel**

**Two Vertical Channels. Two Independent Time-Bases**

**Eight Bit Resolution**

**Codes and Formats Features**

**MP 2401 Features:**

**7D20T Programmable Digitizer**

**70 MHz Bandwidth for Repetitive Signals**

**10 MHz Single-Shot Bandwidth**

**Two Channels Simultaneous Acquisition**

**Storage of up to Six Independent Waveforms**

**Enveloping and Signal Averaging**

The MP 2101 includes the MP 1101 Measurement Package as the acquisition kernel; the MP 2201 includes the MP 1201 Measurement Package for its acquisition kernel.

The MP 2201 Measurement Package provides true dual channel, 200 mS/s digitizing rate, with up to 80 MHz analog bandwidth. It may be tailored for different signal characteristics using 7000 Series plug-in preamplifiers. The MP 2201 performs data processing using BASIC statements.

The MP 2401 is based on the 7D20T Programmable Digitizer and provides an ideal general purpose signal analysis configuration. It packages dual channel configuration with enveloping, averaging, cursor measurements, and comparison to prestored waveforms.

This package includes the 7D20T, a display monitor, 4041 System Controller, the 4105 Color Display Terminal, functional check-out software for easy diagnostics, and cabinet (shipped unassembled).

Both the MP 2101 and MP 2201 include the 4041 System Controller, prepared measurement software, the 4105 Color Display Terminal, and cabinet (shipped unassembled). The 4695 Color Graphics Copier is optional.

Both systems are compact enough to fit on an engineering bench and are also optionally available fully assembled in a cabinet.

### CHARACTERISTICS

#### ENVIRONMENTAL

**Operating Temperature** — +10°C to +35°C (+50°F to +95°F).

**Thermal Output** — MP 2101/MP 2201: Approximately 3750 BTU/hr. MP 2401: Approximately 2900 BTU/hr.

**Operating Altitude** — 4600 m maximum (15,000 ft).

#### POWER REQUIREMENTS

**Standard Operating Voltage** — 115 V (nominal).

**Line Frequency** — 60 Hz.

**Maximum Power Consumption** — MP 2101/MP 2201: 1100 W. MP 2401: 850 W.

#### PHYSICAL CHARACTERISTICS

| Cabinet Dimensions | mm | in | | |
|---|---|---|---|---|
| Height | 419 | 16.5 | | |
| Width | 537 | 21.1 | | |
| Depth | 813 | 32.0 | | |
| **4105** | **Console** | | **Keyboard** | |
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Height | 353 | 13.9 | 41 | 1.6 |
| Width | 419 | 16.5 | 423 | 16.6 |
| Depth | 495 | 19.5 | 180 | 7.0 |

### ORDERING INFORMATION

**MP 2101** Acquisition/Processing Measurement Package ..... **$52,560**
**Option 01** — Delete Plug-ins ..... **−$5,280**

**MP 2201** Acquisition/Processing Measurement Package ..... **$49,600**
**Option 01** — Delete Plug-ins ..... **−4,790**

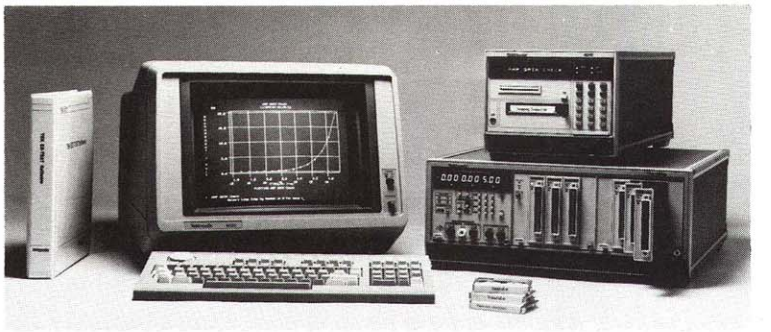
**MP 2401** Acquisition/Processing Measurement Package ..... **$26,895**
**Option 10** — Substitute Tektronix 4107 Color Graphics Terminal for 4105 Color Graphics Terminal. See page 57. (MP 2101, MP 2201, MP 2401) ..... **+$2,955**
**Option 20** — Add Tektronix 4695 Color Graphics Hard Copy Unit. See page 68. (MP 2101, MP 2201, MP 2401) . **+$1,595**

**For additional information on alternate mounting configurations contact your local Tektronix Sales Office and ask for a Sales Engineer.**

# TEK MEASUREMENT PACKAGES INCOMING INSPECTION TEST STATION

NEW

*MP 2501*



*MP 2901*

## GPIB IEEE-488 MP 2501

The MP 2501 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats*.

**7854 Waveform Processing Oscilloscope**
**Dc to 400 MHz Bandwidth at 10 mV/Div**
**Stores Repetitive Waveforms up to 400 MHz (up to 14 GHz with Sampling Plug-ins)**
**Single Shot Events and Pretrigger up to 50 μs/Div with 7B87 Time Base)**

**Enhanced BASIC Language—Resident 4041 BASIC with Numerous Extensions**

The MP 2501 Acquisition/Processing Measurement Package is based on the Tektronix 7854 Waveform Processing Oscilloscope and the 4041 System Controller and is tailored for repetitive signal acquisition and processing up to 400 MHz and 14 GHz with sampling plug-ins.

This package provides flexibility for making controller-assisted measurements in fiber optic testing environments, using Tektronix sampling plug-in units. It uses waveform analysis software (PULSE PARAMETERS) for manufacturing testing, made easy with sample programs, or may be tailored to your specific requirements by selecting from many 7000 Series plug-ins.

The MP 2501 also includes extended 4041 BASIC, functional checkout software for easy diagnostics and the color 4105 Computer Display Terminal. The 4695 Color Graphics Copier is optional.

### CHARACTERISTICS

**ENVIRONMENTAL**

**Operating Temperature** — +10°C to +35°C (+50°F to +95°F).
**Thermal Output** — Approximately 2750 BTU/hr.
**Operating Altitude** — 4600 m maximum (15,000 ft).

**POWER REQUIREMENTS**

**Standard Operating Line Voltage** — 115 V (nominal).
**Line Frequency** — 60 Hz.
**Maximum Power Consumption** — 800 W (nominal).

**PHYSICAL CHARACTERISTICS**

| | 7854 | | Waveform Calculator | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Height | 348 | 13.7 | 81 | 3.2 |
| Width | 305 | 12.0 | 277 | 10.9 |
| Depth | 627 | 24.7 | 152 | 6.0 |

**4105 and 4041 Physical Characteristics in MP 2901 table.**

### ORDERING INFORMATION

**MP 2501** Acquisition/Processing Measurement Package (Order appropriate 7000 Series plug-ins, such as 7A16A, 7B80, and 7B87). (See pages 251 and 258.) ..... **$29,035**
**Option 10** — Substitute Tektronix 4107 Color Graphics Terminal for 4105 Color Display Terminal. See pages 57 .... **$2,955**
**Option 20** — Add Tektronix 4695 Color Graphics Hard Copy Unit. See pages 68 ..... **$1,595**

## GPIB IEEE-488 MP 2901

The MP 2901 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats*.

**Powerful 16 Bit MC68000 Based System Controller**

**BASIC Language Optimized for IEEE Standard 488 Control**

**Test Program Generation by Nonprogrammers**

**Easy Interfacing to Handlers, Probers, and Thermo-Equipment**

**Compatible with IEEE Standard 488 Instruments**

The MP 2901 is especially suited to incoming inspection testing and manufacturing test data logging applications. It provides a wide range of acquisition and stimulus functions required for device testing.

This package includes a 4041 System Controller, a 4105 Color Computer Display Terminal, and a TM 5006 six-wide mainframe with MI 5010/MX 5010 Programmable Multifunction Interface and Extender, and PS 5010 Programmable Triple Power Supply.

TEK EZ-TEST® software is utilized for test procedure generation and development ease.

The MP 2901 is also optionally available fully assembled in a cabinet.*1

**1 Contact your local Tektronix representative for details.*

### CHARACTERISTICS

**ENVIRONMENTAL**

**Operating Temperature** — +10°C to +35°C (+50°F to +95°F).
**Operating Altitude** — 4500 m maximum (15,000 ft).

**POWER REQUIREMENTS**

**Standard Operating Line Voltage** — 115 V (nominal).
**Line Frequency** — 60 Hz.
**Maximum Power Consumption** — 800 W (nominal).

**PHYSICAL CHARACTERISTICS**

| | 4041 | | TM 5006*1 | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Height | 180 | 7.2 | 194 | 7.6 |
| Width | 216 | 8.5 | 445 | 17.5 |
| Depth | 527 | 20.8 | 488 | 19.2 |
| **Weight** | **kg** | **lb** | | |
| Net | 8.8 | 19.5 | 19.5 | 43.0 |
| **4105** | **Console** | | **Keyboard** | |
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Height | 353 | 13.9 | 41 | 1.6 |
| Width | 419 | 16.5 | 423 | 16.6 |
| Depth | 495 | 19.5 | 180 | 7.0 |
| **Weight** | **kg** | **lb** | **kg** | **lb** |
| Net | 20.0 | 44.0 | 2.3 | 5.0 |

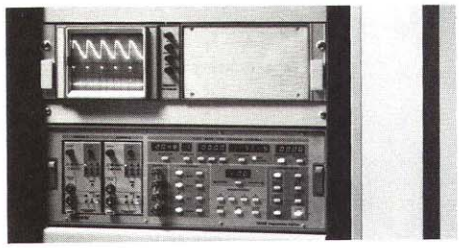
**1 With PS 5010, MI 5010, MX 5010*

### ORDERING INFORMATION

**MP 2901** Incoming Inspection Test Station ..... **$20,325**
**Option 1A** — Add 50M10 A/D Converter Card ..... **+$870**
**Option 1B** — Add 50M20 D/A Converter Card ..... **+$890**
**Option 1C** — Add 50M30 Digital I/O Card ..... **+$480**
**Option 1D** — Add 50M40 Relay Scanner Card ..... **+$675**
**Option 1E** — Add 50M41 Low Level Scanner Card .. **+$995**
**Option 1F** — Add M41A1 Low Level Amplifier ..... **+$500**
**Option 1G** — Add 50M50 16 k Buffer Memory Card . **+$970**
**Option 1H** — Add 50M70 Development Card ..... **+$395**
**Option 10** — Substitute 4107 Color Graphics Terminal for 4105 Color Graphics Terminal. (See page 57.) ..... **+$2,955**
**Option 2A** — Add TM 5006 Mainframe w/Option 02 & 2 m GPIB Cable (Not Compatible with Option 21) ..... **+$1,370**
**Option 2B** — Add TM 5006 Mainframe w/Option 12 & 2 m GPIB Cable (Compatible with Option 21) ..... **+$1,470**
**Option 2C** — Add DM 5010 4.5 Digital Multimeter . **+$2,210**
**Option 2D** — Add FG 5010 20 Hz Function Generator ..... **+$4,400**
**Option 2E** — Add SG 5010 Oscillator ..... **+$4,100**
**Option 2F** — Add PS 5010 ±32 V Triple Power Supply ..... **+$2,990**
**Option 2G** — Add PS 5004 20 V Power Supply ..... **+$1,785**
**Option 2H** — Add DC 5010 350 MHz Digital Counter ..... **+$4,300**
**Option 2J** — Add SI 5010 16 Channel, 350 MHz Scanner ..... **+$2,225**
**Option 2K** — Add MI5010 Multifunction Interface ... **+$1,725**
**Option 2L** — Add MX5010 Interface Extender ..... **+$725**
**Option 2M** — Add DC 5009 135 MHz Digital Counter ..... **+$2,490**
**Option 20** — Add 4695 Color Graphics Hard Copy Unit. (See page 68.) ..... **+$1,595**
**Option 21** — Add Desktop Cabinet and Materials (Includes: 4041 Rackmount Kit and Half Rack-Width Blank Panel, Substitution of TM 5006 Option 12 for TM 5006 Option 02, Full Rack-Width Blank Panel, all mounting hardware). Unassembled ..... **+$1,430**

NEW

*Shown above the MS 4101. The MS 4201 replaces the 7912AD Programmable Digitizer with a 7612D Programmable Waveform Digitizer (see inset). Cart not included.*[1]*



*Shown above is the 7612D contained in the MS 4201. The 7912AD and 7612D are shown and described separately on pages 342 and 340 respectively.*

## GPIB IEEE-488 MS 4101/MS 4201

The MS 4101/MS 4201 comply with IEEE Standard 488-1975.

**High-Performance Waveform Acquisition**

**Fully Programmable Over IEEE Standard 488 Bus for System Oriented Operation**

**Control and Data-Analysis Package**
- **Powerful Waveform and Array Processing**
- **128 k Words of Computer Memory Supported**
- **Flexible Real-Time Instrument Control**
- **Extensive String Processing**
- **Comprehensive Graphics**

**Codes and Format Features**

**MS 4101 Features:**

**Ultra High-Speed Single Shot Digital Storage Capability**

**Up to 200 MHz Bandwidth at 10 mV/Div with Full Programmability**

**Up to 500 MHz Bandwidth at 10 mV/Div with a 7A19 Vertical Plug-in**

**Sweep Speeds up to 500 ps/Div**

**MS 4201 Features:**

**200 Megasamples Per Second Maximum Rate, Each Channel**

**Two Separate Vertical Channels. Two Independent Time-Bases**

*[1] For specifications and ordering information see page 88.*

The MS 4101 and MS 4201 Acquisition/Processing Measurement Systems are self-contained signal acquisition and waveform processing systems. The MS 4101 is based on the Tektronix 7912AD Programmable Digitizer and the MS 4201 is based on the Tektronix 7612D Programmable Waveform Digitizer. Both utilize the Tektronix CP1164X Instrument Controller and two hard-disk drives (similar to the DEC PDP/11-34A Controller with RL02 hard-disk drive) for greater speed than the MS 3101 and MS 3201.

These systems are designed for maximum expandability and computational speed and control up to 56 GPIB instruments, using the TEK SPS BASIC control, data reduction, and graphic display language.

Fully assembled and tested in a full bay cabinet, they also include a 4105 Color Display Terminal. The color hard copy unit and cart are optional.

## CHARACTERISTICS

### ENVIRONMENTAL

**Operating Temperature** — Ambient Air: Nominal is +20°C. Range is +16°C to +24°C. Forced Cooling Air: Nominal is +18°C. Range is +13°C to +22°C. Thermal Shock: <1°C/minute short term. <5°C/hr long term.
**Humidity** — Nominal: 45% relative humidity, noncondensing. Range: 40% to 60% relative humidity, noncondensing.
**Thermal Output** — Approximately 5650 BTU/hr.
**Operating Altitude** — −76 m to 2400 m maximum (−250 ft to 8000 ft).

### POWER REQUIREMENTS

**Standard Operating Line Voltage** — 115 V (nominal).
**Line Frequency** — 60 Hz.
**Maximum Power Consumption** — 1650 W (nominal).

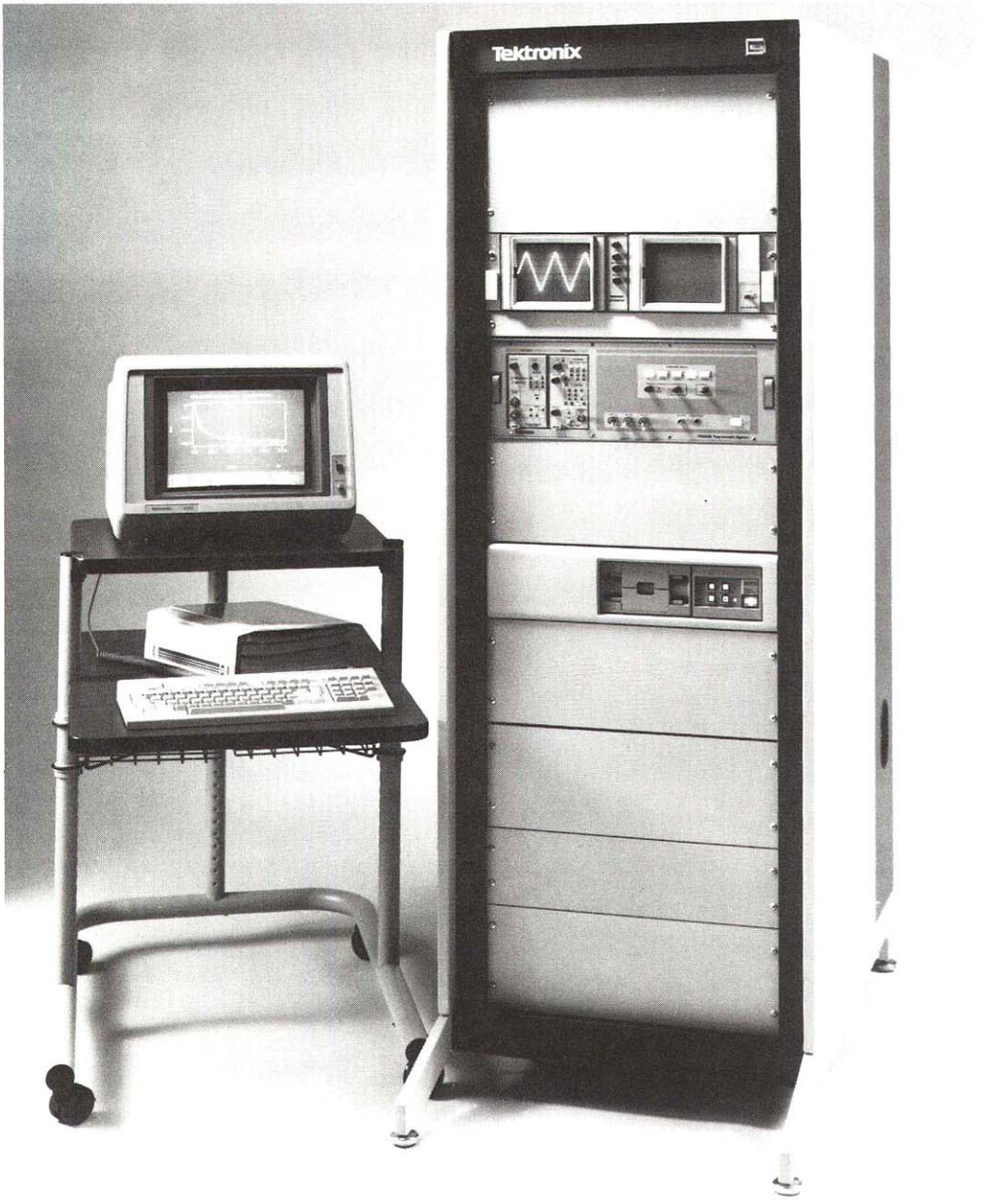
### PHYSICAL CHARACTERISTICS

| Cabinet Dimensions | mm | in | | |
|---|---|---|---|---|
| Height | 1833 | 72.2 | | |
| Width | 616 | 24.3 | | |
| Depth | 1070 | 42.4 | | |
| **4105** | **Console** | | **Keyboard** | |
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Height | 353 | 13.9 | 41 | 1.6 |
| Width | 419 | 16.5 | 423 | 16.6 |
| Depth | 492 | 19.5 | 180 | 7.0 |

## ORDERING INFORMATION

**MS 4101** Acquisition/Processing Measurement System ..... **$99,965**
**Option 01** — Delete Plug-ins ..... **−$5,280**
**MS 4201** Acquisition/Processing Measurement System ..... **$96,300**
**Option 01** — Delete Plug-ins ..... **−$4,790**
**Option 10** — Substitute Tektronix 4107 Color Graphics Terminal for 4105 Color Graphics Terminal. See page 57. ..... **+$2,955**
**Option 20** — Add Tektronix 4695 Color Graphics Copier. (See page 68.) ..... **+$1,595**

NEW




*Shown above is the MS 3101. The MS 3201 replaces the 7912AD Programmable Digitizer with a 7612D Programmable Waveform Digitizer (see inset). Cart not included.*[1]*

GPIB IEEE-488

## MS 3101/MS 3201

The MS 3101 and MS 3201 comply with IEEE Standard 488-1975.

**High-Performance Waveform Acquisition**

**Control and Data-Analysis Package**
- Powerful Waveform and Array Processing
- 128 k Words of Computer Memory Supported
- Flexible Real-Time Instrument Control
- Extensive String Processing
- Comprehensive Graphics

**Codes and Formats Features**

*[1] For specifications and ordering information see page 88.*

**MS 3101 Features:**

**Ultra High-Speed Single Shot Digital Storage Capability**

**Up to 200 MHz Bandwidth at 10 mV/Div with Full Programmability**

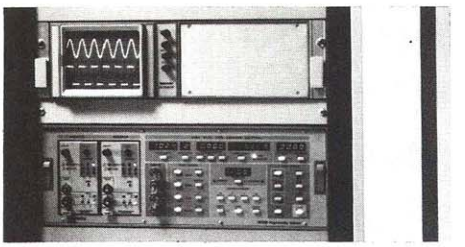
**Up to 500 MHz Bandwidth at 10 mV/Div with a 7A19 Vertical Plug-in**

**MS 3201 Features:**

**200 Megasamples Per Second Maximum Rate, Each Channel**

**Two Separate Vertical Channels. Two Independent Time Bases**

**Eight Bit Resolution**



*Shown above is the 7612D contained in the MS 3201. The 7912AD and 7612D are shown and described separately on pages 342 and 340 respectively.*

The MS 3101 and MS 3201 Acquisition/Processing Measurement Systems are self-contained signal acquisition and waveform processing systems. The MS 3101 is based on the Tektronix 7912AD Programmable Digitizer for excellent single-shot acquisition capability. The MS 3201 is based on the Tektronix 7612 Programmable Digitizer for excellent dual-channel acquisition capability. Both utilize the 119-1834-00 (DEC MICRO/PDP-11) Instrument Controller which use the MP 1101 Measurement Package or 1201 Measurement Package for the acquisition kernel.

Both include a 10 megabyte Winchester disk and dual 5 1/4 inch flexible diskette drives, contained in a compact 5 1/4 inch controller height configuration.

They can control up to 56 GPIB instruments, using the TEK SPS BASIC control, data reduction, and graphic display language.

Fully assembled and tested in a full bay cabinet, they also include a 4105 Color Display Terminal. The color hard color unit and cart are optional.

## CHARACTERISTICS

### ENVIRONMENTAL

**Operating Temperature** — Ambient Air: Nominal is +20°C. Range is +16°C to +24°C. Forced Cooling Air: Nominal is +18°C. Range is +13°C to +22°C. Thermal Shock: <1°C/minute short term. <5°C/hr long term.
**Humidity** — Nominal: 45% relative humidity, noncondensing. Range: 40% to 60% relative humidity, noncondensing.
**Thermal Output** — Approximately 3750 BTU/hr.
**Operating Altitude** — −76 m to 2400 m maximum (−250 ft to 8000 ft).

### POWER REQUIREMENTS

**Standard Operating Line Voltage** — 115 V (nominal).
**Line Frequency** — 60 Hz.
**Maximum Power Consumption** — 1100 W (nominal).

### PHYSICAL CHARACTERISTICS

| Cabinet Dimensions | mm | in | | |
|---|---|---|---|---|
| Height | 1833 | 72.2 | | |
| Width | 616 | 24.3 | | |
| Depth | 1070 | 42.4 | | |
| **4105** | **Console** | | **Keyboard** | |
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Height | 353 | 13.9 | 41 | 1.6 |
| Width | 419 | 16.5 | 423 | 16.6 |
| Depth | 492 | 19.5 | 180 | 7.0 |

## ORDERING INFORMATION

**MS 3101** Acquisition/Processing Measurement System ..... **$72,865**
**Option 01** — Delete Plug-ins ..... **−$5,280**

**MS 3201** Acquisition/Processing Measurement System ..... **$69,200**
**Option 01** — Delete Plug-ins ..... **−$4,790**
**Option 10** — Substitute Tektronix 4107 Color Graphics Terminal for 4105 Color Graphics Terminal. (See page 55.) ..... **+$2,955**
**Option 20** — Add Tektronix 4695 Color Graphics Copier. (See page 68.) ..... **+$1,595**

# TM 5000 GPIB PROGRAMMABLE INSTRUMENTS

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### Designed for Configurability; for Programming Ease; for Productivity.

Test and measurement setup has never been this friendly, has never been this fast. With Tek's line of TM 5000 programmables, you can continue to build on the concept of configurability. You can now link together customized, automated test packages with the same plug-in, pull-out ease as found in our TM 500 manual instrument line. You'll find these IEEE Standard 488 compatible, fully programmable instruments are among the friendliest and fastest to integrate you can buy.

The 350 MHz DC 5010 Universal Counter/Timer is the state-of-the-art in high performance universal counter/timers. Its 1 ps time interval averaging resolution is unmatched for the industry.

For lower speeds, the 135 MHz DC 5009 Universal Counter/Timer is the industry's lowest cost, fully programmable counter/ timer. It provides all of the functions of the higher-performance DC 5010 except rise/fall and null.

The DP 501 Digital Prescaler, although not GPIB compatible by itself, extends the frequency measurement capability of the DC 5010 and DC 5009 to 1.3 GHz under program control.

The DM 5010 Digital Multimeter measures dc and true RMS ac volts, ohms, and provides a diode test function. Internal math capabilities include averaging, nulling, offset, scaling, dB, and HI/LO/Pass sorting.

The FG 5010 Function Generator features variable symmetry throughout the full 20 MHz bandwidth of the instrument. Other important functions include counted burst, phase lock, and the ability to store and recall ten complete front panel setups.

The PS 5010 Power Supply, with its three separately programmable supplies, provides the most widely used voltages, all under complete program control, including current limit, source on/off, and extensive status reporting.

The PS 5004 Precision Power Supply provides the high-resolution voltages and currents necessary in the characterization of transistors, ICs, and other semiconductor and hybrid circuits. The actual values of the output voltage, output current, and current limit may be read directly from the 4½-digit front panel display or are available over the GPIB.

The AA 5001 Programmable Distortion Analyzer and SG 5010 Programmable Oscillator are the world's first truly high-performance programmable audio test instruments. Together, they provide unequaled capability covering the full range of standard audio testing—THD, IMD, (SMPTE, DIN, CCIF difference tone), gain/loss, and signal-to-noise ratio. The AA 5001 is fully automatic in each of its operating modes—no tuning, no nulling, no level setting, no range changing—even with a remotely located signal source.

A complete range of system control and signal routing capabilities are available with the MI 5010 Multifunction Interface and MX 5010 Multifunction Interface Extender and the SI 5010 350 MHz Programmable Scanner. Function cards currently available for the MI 5010/MX 5010 Multifunction Interface System include: D/A converter, A/D converter, 32-channel digital I/O, 16-channel relay scanner, 10-channel low-level scanner, 16 k memory, and user-configurable development card.

Each TM 5000 instrument (with the exception of the completely automatic AA 5001) is fully programmable—all front panel functions are programmable over the GPIB. Each instrument (again with the exception of the AA 5001) has a front-panel ID button which can be programmed to cause the instrument to generate an SRQ when pushed, to allow operator intervention in an on-going test. Conversely, the SRQ generation capability can be programmed off to prevent inadvertent operator intervention. In addition, the entire front panel of each instrument can be locked out to further prevent operator interference with a test or instrument setup. When used with the execute-only version of the Tektronix 4041 System Controller, this means that you can place a completely operator-proof test system on the manufacturing floor; the operator can intervene only to the extent permitted by the test programmer.

In addition, Tektronix ***Standard Codes and Formats*** provides standardized data formats among all TM 5000 instruments, and among all other Tektronix GPIB instruments as well. Standardized instrument data formats open up the lines of bus communication and make your test and measurement system easy to set up and operate. Test and control functions are changed quickly and easily. Common error codes among instruments greatly simplify error-handling routines.

All of the TM 5000 instruments have internal diagnostics capability built right in. Each instrument performs an extensive diagnostic self-test on power-up or on command and, in case of a fault, displays and/or sends over the GPIB an error message indicating the nature of the fault. To further aid in troubleshooting and maintenance of the instruments, each has built-in signature analysis capability; each instruction manual gives a comprehensive list of signatures at nodes throughout the instrument.

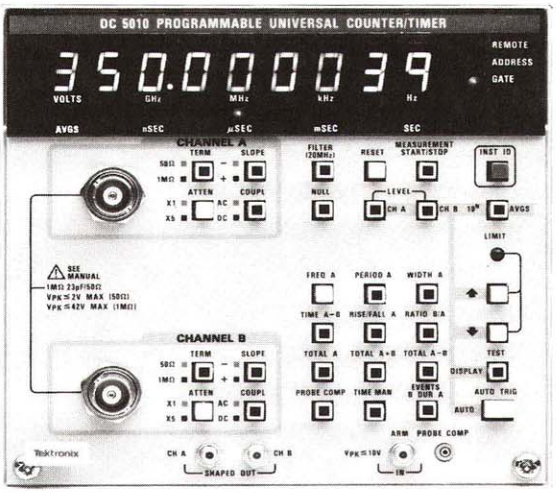
The compact, modular TM 5000 instruments operate in the TM 5003 and TM 5006 mainframes to form configurable automated test systems which occupy less than half the rack space of ordinary rackmounted equipment. The adjoining photo shows five TM 5000 instruments (DM 5010, DC 5009, MI 5010, FG 5010, and PS 5010) plus the powerful 4041 System Controller configured in a benchtop system approximately 15 inches high and 17 inches wide.

All of the current TM 5000 instruments are double-width, with the exception of the single-width DC 5009 and PS 5004. That is, each (except the DC 5009 and PS 5004) occupy two compartments of the three-compartment TM 5003 or the six-compartment TM 5006 mainframes.

Adherence to standard form and fit means that any TM 5000 product can be replaced in a system without the uncabling, unstacking, restacking, and recabling that is necessary with most instruments. Rebuilding the system for a different task takes seconds, not hours. And, if all instruments in your system need not be programmable, all 35-plus of Tek's TM 500 line of manual instruments are also compatible with TM 5000 mainframes.

All TM 5000 instruments are UL listed.

**DC 5010**




**Programmable Universal Counter/Timer**

## GPIB IEEE-488 DC 5010

The DC 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

- **350 MHz Both A and B Channels**
- **3.125 ns Single-Shot Resolution**
- **9-Digit Display**
- **1 ps Resolution, with Averaging**
- **Measurement Functions Include:**
  - **Reciprocal Frequency Measurement**
  - **Period**
  - **Width**
  - **Time A→B**
  - **Events B During A**
  - **Totalize A, A+B, A−B**
  - **Ratio**
  - **Rise/Fall**
  - **Time Manual**
  - **Arming**
  - **Null**
- **Auto or Selected Averaging to $10^9$ in All Modes**
- **Duty-Cycle Independent Autotrigger**
- **DVM Mode for Displaying Trigger Level Setting**
- **Shaped A and B Channel Outputs**
- **Hysteresis Compensation**
- **Probe Compensation**

Frequency measurements to 350 MHz (to 1.3 GHz with the Tektronix DP 501 Digital Prescaler), a wide range of time-interval measurement capabilities including rise and falltimes, hysteresis compensation, probe compensation, arming, and high resolution on low frequency signals (up to nine digits in one second or less), all combine to make the DC 5010 a true state-of-the-art universal counter/timer. Selected averaging of up to $10^9$ events provides usable time-interval resolution to 1 ps on repetitive signals. The automatic averaging feature provides a compromise between measurement time and resolution, regardless of input signal frequency. The pseudo-random, phase modulated clock provides increased accuracy by eliminating the possibility of clock-synchronous errors in the time-interval averaging modes. Hysteresis compensation is automatic, further increasing the accuracy of time-interval measurements in the DC 5010. The Null feature permits the nulling of differences in cable lengths in time-intervalmeasurements to provide direct readout of the measurement of interest.

Autotrigger, at the push of a button or upon command over the GPIB, senses the maximum and minimum of the applied signal and sets trigger level to a point midway between the two, regardless of duty cycle. The values of the maximum and the minimum are available over the bus where they can be used by the controller to compute the p-p amplitude of the signal, providing the function of a high-frequency p-p DVM. The value of the trigger level is also available over the bus, and may also be displayed in the nine-digit DC 5010 display. The outputs of both channels' signal shaping circuits are available at the front panel to aid in the proper setting of trigger levels on complex waveforms. The arming input allows measurement of selected events within complex waveforms. The unique Probe Compensation feature permits quick and accurate compensation of attenuator-type probes to provide accurate measurements on signals beyond the amplitude range of the counter itself.

The frequency measurement of the DC 5010 can be extended to 1.3 GHz with the use of the companion DP 501 Digital Prescaler. TM 5000 rear interfacing capability permits the operation of the DP 501 to be controlled over the GPIB through the DC 5010.

A field-installable modification kit is available to upgrade a manual DC 510 Universal Counter/Timer (page 370) to a GPIB programmable DC 5010 Universal Counter/Timer.

## CHARACTERISTICS

**Display** — Nine-digit LED display, automatic decimal point positioning, LED indicators for units, and measurement gate, and bus conditions. Overflow is indicated by a blinking display.

**CHANNEL A AND CHANNEL B INPUT CHARACTERISTICS**

**Frequency Range**

50 Ω Termination: 0 MHz to 350 MHz dc coupled. 100 kHz to 350 MHz ac coupled.

1 MΩ Termination: 0 MHz to 300 MHz dc coupled. 16 Hz to 300 MHz ac coupled.

**Sensitivity**

50 Ω Termination Dc: 25 mV RMS sinewave to 350 MHz. 70 mV p-p pulse.

1 MΩ Termination Ac: 25 mV RMS to 200 MHz, 42 mV RMS to 300 MHz.

**Attenuation** — Selectable 1X, 5X.

**Impedance** — 1 MΩ paralleled by 23 pF ±2 pF or 50 Ω.

**Trigger Level Range** — +2 V to −2 V with 4 mV resolution (X1). +10 V to −10 V with 20 mV resolution (X5).

**Trigger Level Accuracy** — ±2% of reading for a dc input V, ±40 mV x attenuator.

**Dynamic Range** — 4 V p-p x attenuation.

**Autotrigger Frequency Range** — 10 Hz to 350 MHz.

**Independent Controls** — Slope +/−, atten 1X/5X, Coupl ac/dc, Imped 1 MΩ/50 Ω.

**Maximum Input Voltage** — 1 MΩ input impedance.

1X: ±42 V (dc + peak ac) to 200 kHz; ±2 V (dc + peak ac) to 300 MHz.

5X: ±42 V (dc + peak ac) to 1 MHz; ±10 V (dc + peak ac) to 300 MHz.

In 50 Ω Input Impedance: Signals > ±2 V x attenuator will cause input protection circuitry to switch input to 1 MΩ.

**Shaped Out** — Shaped replica of signal being measured, aids proper triggering on complex waveforms (≥100 mV typically to 350 MHz into 50 Ω load).

**Arming Input** — Permits measurements of complex waveforms. A TTL high allows averaging of selected events within a measurement.

**FREQUENCY A**

**Range** — 36 μHz to 350 MHz.

**Resolution** —

$$\pm\text{LSD} \pm 1.4 \times \frac{\text{A Trigger Jitter Error}}{N} \times (\text{Frequency A})^2$$

**Accuracy** — Resolution ± (Time Base Error x Frequency A)

**PERIOD A**

**Range** — 3.125 ns to 7.6 hrs.

**Resolution** —

$$\pm\text{LSD} \pm \frac{1.4 \times \text{A Trigger Jitter Error}}{N}$$

**Accuracy** — Resolution ± (Time Base Error) x Period A.

**RATIO B/A**

**Range** — $10^{-8}$ to $10^9$ (Frequency range 36 μHz to 350 MHz).

**Resolution** —

$$\pm\text{LSD} \pm \frac{1.4 \times \text{B Trigger Jitter Error X Frequency B}}{N}$$

**Accuracy** — Same as Resolution.

**TIME A→B**

**Range** — 2.0 ns to 7.6 hrs.

**Resolution** —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}} \times (\pm \text{ CH A Trig Jitter Error} \pm \text{CH B Trig Jitter Error})$$

**Accuracy** — Resolution ± (Time Base Error x Time A→B) + (B Trigger Slew Error) − (A Trigger Slew Error) ± (Channel Delay Mismatch*1).

**Resolution** — Best time A→B Avg resolution = ±1 ps.

**Minimum Dead Time** — 12.5 ns (stop to start).

**Rep Rate** — <70 MHz.

*1 *Can be removed with "Null".*

Refer to Digital Counter Selection Guide on Page 370.

### EVENTS B DURING A

**Range** — $10^{-8}$ to $10^{9}$.

**Maximum B Frequency** — 350 MHz.

**Maximum A Frequency** — 80 MHz.

**Minimum A Pulse Width** — 4.0 ns (and 8.5 ns minimum time between pulses).

**Resolution** —

$$\pm\text{LSD} + \frac{\text{Frequency B}}{\sqrt{N}} \pm(\text{Trig Jitter Error CH A start edge} \pm \text{Trig Jitter Error CH A stop edge}).$$

**Accuracy** — Resolution + Freq B (Stop Slew Rate Error − Start Slew Rate Error) + Freq B x (5 ±2 ns).

### WIDTH A

**Range** — 4 ns to 7.6 hrs.

**Resolution** —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}}(\pm\text{Start Trig Jitter Error} \pm \text{Stop Trig Jitter Error})$$

**Accuracy** — Resolution ±(Time Base Error x Width A) + (Stop Slew Rate Error − Start Slew Rate Error) ±2 ns.

**Minimum Dead Time Between Pulses** — ≤8.5 ns.

**Repetition Rate** — 50 MHz maximum.

### TIME MANUAL

**Range** — 0 to 3.125 x $10^{4}$ s (≈8 hrs).

**Resolution** — ±LSD (100 ms).

**Accuracy** — ±Resolution ±(Time Base Error x Time).

### TOTALIZE A

**Range** — 0 to $10^{9}$ counts.

**Repetition Rate** — 0 to 350 MHz.

### TOTALIZE A+B

**Range** — 0 to $10^{9}$ counts (A+B ≤$10^{9}$).

**Repetition Rate** — 0 to 350 MHz.

### TOTALIZE A−B

**Range** — −1 x $10^{8}$ to +1 x $10^{9}$ (either A >$10^{12}$ or B >$10^{12}$ will cause overflow).

**Repetition Rate** — 0 to 350 MHz.

### RISE/FALL A

**Range** — 4 ns to $10^{4}$ s (50 Ω) 5 ns to $10^{4}$ s (1 MΩ).

**Repetition Rate** — Minimum time between rising (falling) edges is 12.5 ns (80 MHz).

**Input Amplitude** — (1.4 V to 8 V) x Attenuation (50 Ω), (0.7 V to 4 V) x Attenuation (1 MΩ).

**Resolution** —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}}(\pm\text{Start Trig Jitter Error} \pm \text{Stop Trig Jitter Error})$$

**Accuracy** — Resolution ±(Time Base Error x Risetime/Falltime) ±2 ns ±4 mV x Slew Rate A Error (near 10%) ±4 mV Slew Rate A Error (near 90%).

### RESOLUTION AND ACCURACY DEFINITIONS

$$\frac{\text{Trigger Jitter Error (seconds RMS)} = \sqrt{(e_{n1})^2 + (e_{n2})^2\ \text{(Volts RMS)}}}{\text{Input Slew Rate at trigger point (V/s)}}$$

*Where:* $e_{n1}$ = *140 μV RMS typical counter input noise for 1 MΩ filter on; 250 μV RMS typical for 1 MΩ, filter off and 340 μV RMS typical for 50 Ω.*

$e_{n2}$ = *RMS Noise Voltage of input signal at trigger point measured with 350 MHz bandwidth.*

**Slew Rate Error (Seconds)** — $\frac{\text{trigger level error (V)}^{*1}}{\text{Input slew rate at trigger point (V/s)}}$

*1Trigger level error =

| | | |
|---|---|---|
| All functions except Width and Events B During A | Positive Slope | Trigger accuracy times ATTN factor |
| | Negative Slope | (trigger accuracy ±10 mV) times ATTN factor |
| Width A ⎍ | start edge | trigger accuracy times ATTN factor |
| | stop edge | (trigger accuracy + hyst) times ATTN factor |
| ⎍ | start edge | (trigger accuracy + hyst) times ATTN factor |
| | stop edge | trigger accuracy times ATTN factor |
| Events B During A | Same as Width, except each number is multiplied by (Frequency B) | |

*Note: Input hysteresis is typically 50 mV p-p x attenuation. N=Number of events averaged.*

The minimum number of averages is selected by the Averages button and the ↑ ↓ buttons in decade steps from 1 to $10^{9}$. At Channel A repetition rates above ≈250 Hz the actual number of averages will be:

N = [Frequency A (Hz) x 4 ms] + Averages.
N = Averages setting (below 250 Hz).

This calculation typically leads to better than expected resolution in the displayed answer for small N with only minimal impact on measurement time. It does mean, however, that Arming must be used where only N = 1 is desired for signals ≥250 Hz.

In the Auto mode the counter measures with a fixed measurement time of about 300 ms (or the time for one event, whichever is greater).

N = Frequency A (Hz) x 0.3 s (N always ≥1).

Probe Comp display indicates 1 for over comp, 0 for under comp. Accuracy = (A x 0.300)%. A = Probe Attenuation times counter attenuator setting.

**Time Base Error** — The sum of all errors specified for the time based used.

### STANDARD TIME BASE

**Crystal Frequency** — 10 MHz.
**Temperature Stability** — ±5 x $10^{-6}$, 0°C to +50°C.
**Aging Rate** — ≤1 x $10^{-6}$/year.
**Setability** — Adjustable to within ±5 x $10^{-8}$.

### HIGH STABILITY TIME BASE (OPTION 01)

**Crystal Frequency** — 10 MHz.
**Temperature Stability** — ±2 x $10^{-7}$ of final frequency in <10 minutes when cold started at 25°C.
**Aging Rate** — ≤1 x $10^{-8}$/day at time of shipment, 4 x $10^{-8}$/week after 30 days of continuous operation, 4 x $10^{-6}$/year after 60 days of continuous operation.
**Setability** — Adjustable to within ±2 x $10^{-8}$.

### REAR INTERFACE

**Inputs** — Arming; reset; external time base (1 MHz, 5 MHz, or 10 MHz).
**Outputs** — 1 MHz clock.

### OTHER CHARACTERISTICS

**Power Consumption** — 14.5 W (≈19.. W or Option 01).
**GPIB Data Output Rate** — ≈10 readings/s maximum.
**TM 5000 Power Module Compatibility** — The DC 5010 is not compatible with TM 500 Series mainframes.

### INCLUDED ACCESSORIES

Shaped output cable (012-0532-00); instruction manual; reference guide; instrument interfacing guide.

## ORDERING INFORMATION

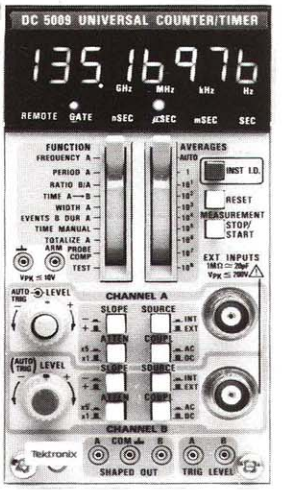
**DC 5010** Programmable Universal Counter/Timer ..... **$4,300**
**Option 01** — High Stability Time Base ..... **+$325**
**Field Option 01 Kit** — For DC 510/5010. Order 040-0966-00 ..... **$250**

**Utility Software**
For TM 5000/4041 Order 062-6958-01 ..... **$150**
For TM 5000/4052A Order 062-6957-01 ..... **$150**
Refer to page 323 for description and ordering information.

### RECOMMENDED PROBE

**P6125** — 5X Passive Probe. Order 010-6125-01 ..... **$70**

## DC 5009




**Programmable Universal Counter Timer**

GPIB IEEE-488

## DC 5009

The DC 5009 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

- **135 MHz Both A and B Channels**
- **10 ns Single-Shot Resolution**
- **8-Digit Display**
- **5 ps Resolution, with Averaging**
- **Measurement Functions Include:**
  - **Reciprocal Frequency Measurement**
  - **Period**
  - **Width**
  - **Time A→B**
  - **Events B During A**
  - **Totalize A→B**
  - **Ratio**
  - **Time Manual**
  - **Arming**
- **Auto or Selected Averaging to $10^{8}$ in All Modes**
- **Duty-Cycle Independent Autotrigger**
- **Shaped A and B Channel Outputs**
- **Probe Compensation**

The DC 5009 single-width Universal Counter/Timer provides all of the measurement functions of the higher performance DC 5010 except risetime/falltime, null, and totalize A ± B. This makes it the lowest cost fully programmable universal counter/timer available at the present time.

Refer to Digital Counter Selection Guide on Page 370.

The powerful reciprocal frequency measurement technique allows up to eight digits of resolution of low frequency signals in one second or less of measurement time. The DC 5009 has the same automatic averaging feature as the DC 5010; selected averaging of up to $10^8$ events provides usable time-interval resolution of 5 ps.

Like the DC 5010, the frequency measurement capability of the DC 5009 can be extended to 1.3 GHz with the use of the DP 501 Digital Prescaler. The TM 5000 rear interfacing capability allows the operation of the DP 501 to be controlled over the GPIB through the DC 5009.

A field-installable modification kit is available to upgrade a manual DC 509 Universal Counter/Timer (page 371) to a GPIB programmable DC 5009 Universal Counter/Timer.

## CHARACTERISTICS

**Display** — Eight-digit LED display, automatic decimal point positioning, LED indicators for units, and measurement gate. Overflow is indicated by a blinking display.

### CHANNEL A AND B INPUT CHARACTERISTICS

**Frequency Range** — 0 MHz to 135 MHz dc coupled, 10 Hz to 135 MHz ac coupled.

**Sensitivity** — 20 mV RMS sinewave to 100 MHz, 40 mV RMS sinewave to 135 MHz, 115 mV p-p at minimum, pulse width of 3 ns.

**Attenuation** — Selectable 1X, 5X.

**Impedance** — 1 MΩ paralleled by ≤30 pF.

**Trigger Level Range** — +3.200 V to −3.175 V with 25 mV resolution (X1). +16 V to −15.875 V with 125 mV resolution (X5).

**Trigger Level Accuracy** — ±45 mV ±40 μV/°C referenced to 25°C.

**Auto Trigger Frequency Range** — 20 Hz to 100 MHz ($V_{in}$ ≥125 mV p-p).

**Dynamic Range** — V p-p ≤3 x Attenuation, tr ≤5 ns. V peak ≤3.2 x Attenuation.

**Independent Controls** — Slope +/−, Attenuation 1X/5X, Couple ac/dc, Source Internal/External.

**Maximum Input Voltage**
1X: 200 V peak; 400 V p-p from dc to 50 kHz, derate to 15 V p-p at 135 MHz.
5X: 200 V peak; 400 V p-p from dc to 5 MHz, derate to 25 V p-p at 135 MHz.

**Shaped Out** — Shaped replica of signal being measured, aids proper triggering on complex waveforms. Amplitude 0 V to ≥+0.3 V from 50 Ω.

**Trigger Level Out** — A dc level corresponding to the actual trigger level. Accuracy within ±30 mV of internal trigger level.

**Arming Input** — Permits measurements of complex waveforms. A TTL high allows averaging of selected events within a measurement.

### FREQUENCY A

**Range** — 100 μHz to 135 MHz.

**Resolution** —

$$\pm\text{LSD} \pm 1.4 \times \frac{\text{Trigger Jitter Error}}{N} \times (\text{Frequency A})^2$$

**Accuracy** —
Resolution ±(Time Base Error x Frequency A)

### PERIOD A

**Range** — 7.40 ns to 3.05 hrs.

**Resolution** —

$$\pm\text{LSD} \pm 1.4 \times \frac{\text{A Trigger Jitter Error}}{N}$$

**Accuracy** — Resolution ±(Time Base Error x Period A).

### RATIO B/A

**Range** — $10^{-7}$ to $10^8$ (Frequency Range: CH A to 135 MHz; CH B to 125 MHz.)

**Resolution** —

$$\pm\text{LSD} \pm 1.4 \times \frac{\text{B Trigger Jitter Error x Frequency B}}{N}$$

**Accuracy** — Same as Resolution.

### TIME A → B

**Range** — 15 ns to 3.05 hrs.

**Minimum Dead Time** — 15 ns (stop to start).

**Resolution** —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}} \times (\pm\text{CH A Trigger Jitter Error} \pm \text{CH B Trigger Jitter Error})$$

**Accuracy** — Resolution ±(Time Base Error x Time A → B) + (CH B Slew Rate Error − CH A Slew Rate Error) ±Channel Delay Mismatch.

**Channel Delay Mismatch** — <2 ns between front panel inputs and <3 ns between rear interface inputs.

### EVENTS B DURING A

**Range** — $10^{-7}$ to $10^8$.

**Maximum B Frequency** — 125 MHz.

**Minimum A Pulse Width** — 15 ns.

**Minimum Time Between A Pulses** — 15 ns.

**Minimum Time Between "A" Start Edge and First "B" Event** — 15 ns.

**Resolution** —

$$\pm\text{LSD} + \frac{\text{Frequency B}}{\sqrt{N}} (\pm\text{Trigger Jitter Error CH A start edge} \pm \text{Trigger Jitter Error CH A stop edge.})$$

**Accuracy** — Resolution + Frequency B (Stop Slew Rate Error — Start Slew Rate Error).

### WIDTH A

**Range** — 15 ns to 3.05 hrs.

**Minimum Dead Time Between Pulses** — 15 ns.

**Resolution** —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}} (\pm\text{Start Error} \pm \text{Stop Trigger Jitter Error})$$

**Accuracy** — Resolution ±(Time Base Error x Width) + (Stop Slew Rate Error — Start Slew Rate Error) ±5 ns.

### TIME MANUAL

**Range** — 0 to 3.05 hrs. May be extended with GPIB.

**Resolution** — ±LSD (100 ms).

**Accuracy** — ±Resolution ±(Time Base Error x Time).

### TOTALIZE A

**Range** — 0 to 1.09 x $10^{12}$ counts. May be extended with GPIB.

**Repetition Rate** — 0 MHz to 135 MHz.

### PROBE COMPENSATION

**Display** — 1 or 0 for each channel.

**Accuracy** —

$$\frac{\text{Probe Atten X 50 mV X 100 (\%)}}{V_{in} \text{ at Probe}}$$

(2.5% nominal for X5 probe with 10 V p-p at the probe).

### RESOLUTION AND ACCURACY DEFINITIONS

**Trigger Jitter Error (Seconds RMS)** —

$$\frac{\sqrt{(e_{n1})^2 + (e_{n2})^2 \text{ (Volts RMS)}}}{\text{Input Slew Rate at trigger point (V/s)}}$$

*Where: $e_{n1}$ = 120 μV RMS typical counter input noise*
*$e_{n2}$ = RMS Noise Voltage of input signal at trigger point measured with 150 MHz bandwidth.*

**Slew Rate Error (Seconds)** —

$$\frac{\text{Input Hysteresis/2}}{\text{Input Slew Rate at trigger point (V/s)}}$$

*Note: Input hystersis is typically 20 mV p-p.*

**N = Number of Events Averaged**

The minimum number of averages is selected by the Averages control in decade steps from 1 to $10^8$. At CH A repetition rates above ≈250 Hz, the number of events averaged will be:

N = [Frequency A (Hz) x 4 ms] +Averages.

N = Averages setting below 250 Hz.

In the Auto mode, the counter measures with a fixed measurement time of about 300 ms.

N (Auto) ≈ Frequency A (Hz) x 0.3 s.

N is always ≥1.

**Time Base Error** — The sum of all errors specified for the time base used.

### STANDARD TIME BASE

**Crystal Frequency** — 10 MHz.

**Temp Stability** — ±5 x $10^{-6}$, 0°C to +50°C.

**Aging Rate** = 1 x $10^{-6}$ per year.

**Setability** — Adjustable to within ±1 x $10^{-7}$ or better.

### HIGH STABILITY TIME BASE (OPTION 01)

**Crystal Frequency** — 10 MHz.

**Stability** — ±2 x $10^{-7}$ after warm-up, 0°C to +50°C.

**Warm-up Time** — Within 2 x $10^{-7}$ of final frequency in <10 minutes when cold-started at 25°C.

**Aging Rate** — 1 x $10^{-8}$/day at time of shipment, 4 x $10^{-8}$/week after 30 days of continuous operation, 1 x $10^{-6}$/year after 60 days of continuous operation.

**Setability** — Adjustable to within 2 x $10^{-8}$.

### REAR INTERFACE

**Inputs** — Channel A and Channel B input to 50 MHz (50 Ω impedance, maximum input 3.6 V peak); arming; reset; external time base (1 MHz, 5 MHz, or 10 MHz), prescale.

**Outputs** — Channel A and Channel B shaped outputs; Channel A and Channel B trigger level outputs; 10 MHz clock; gate out.

### OTHER CHARACTERISTICS

**Power Consumption** — ≈12 W (≈15 W with Option 01).

**GPIB Data Output Rate** — ≈10 readings/s maximum.

### INCLUDED ACCESSORIES

Tip jack to BNC adaptor cable (175-3765-01); instruction manual; reference guide; instrument interfacing guide.

## ORDERING INFORMATION

**DC 5009** Programmable Universal Counter Timer ..... **$2,490**

**Option 01** — High Stability Time Base ..... **+$325**

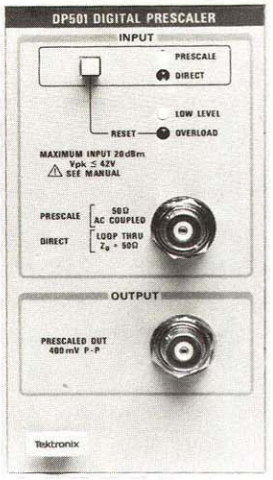
**Field Option 01 Kit** — For DC 509 Order 040-0966-00 ..... **$250**

**Utility Software**
For TM 5000/4041 Order 062-6958-01 ..... **$150**
For TM 5000/4052A Order 062-6957-01 ..... **$150**
Refer to page 323 for description and ordering information.

### RECOMMENDED PROBE

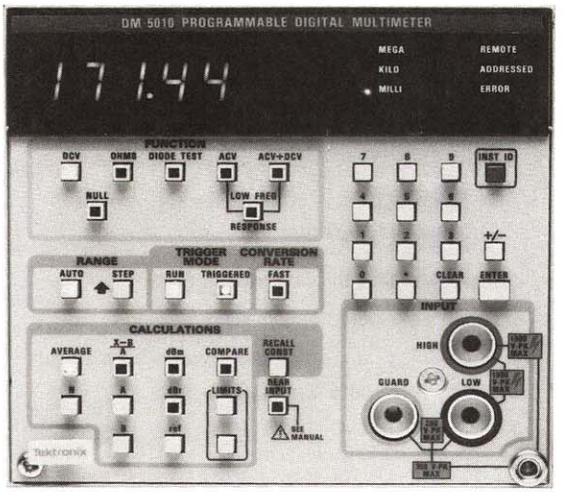
**P6125** — 5X Passive Probe. Order 010-6125-01 ..... **$70**

**DP 501**




Digital Prescaler

**DM 5010**




Programmable Digital Multimeter

## DP 501

**Extends Frequency Measurement Capability to 1.3 GHz**

**Compatible with Most TM 5000 and TM 500 Counters**

**AGC**

**Low Level Indicator**

The DP 501 Digital Prescaler adds 1.3 GHz frequency counting capability to the Tektronix DC 509/5009, DC 510/5010, and DC 503A Universal Counter/Timers while still allowing full use of all counter/timer functions. There is no need to change input connections as with counters which use the conventional C-Channel input.

The DP 501 is placed in the signal line between the signal source and the counter's input connector such that the signal to be measured passes through the DP 501. Two operating modes are available, Prescale and Direct. In the Prescale mode, the DP 501 divides the input signal frequency by 16 and the associated counter's display to be multiplied by 16 (so that the counter will display the correct frequency). In the Direct mode the signal is simply looped through the DP 501 and applied directly to the counter's input; the counter's display is not affected. This loop-through capability eliminates the need for external switching of the input signal when changing from high frequency measurements to low frequency or time-interval measurements.

The prescaling function can be activated in either of two ways: manually, with a front-panel pushbutton; or, by the "Prescale On" command to the counter when using a GPIB programmable DC 5009 or DC 5010.

Input sensitivity in the Prescale mode is 20 mV RMS to 1 GHz and 30 mV RMS to 1.3 GHz. A Low-Level indicator alerts the user if the input signal amplitude is too low for error-free counting.

An automatic gain control circuit provides optimum immunity to signal noise in the Prescale mode.

The DP 501 and the DC 509/DC 5009 or DC 510/DC 5010 Universal Counter/Timers can be used with the Tektronix 7L14 Spectrum Analyzer (see page 210) and TR 502 Tracking Generator (see page 214) to provide counter accuracy measurements of swept-frequency signals from 100 kHz to 1.3 GHz.

The DP 501 operates in a single compartment of either a TM 500 or TM 5000 mainframe.

### CHARACTERISTICS

**Prescale Mode**
Input: Frequency range is ≤100 MHz to ≥1.3 GHz.
Sensitivity: 100 MHz to 1 GHz is ≤20 mV RMS (−21 dBm).
1 GHz to 1.3 GHz is ≤30 mV RMS (−17 dBm).
Impedance: 50 Ω ac coupled; vswr ≤2.2:1.
Output: Amplitude into 50 Ω is ≥200 mV. Unterminated is 2X terminated value.

**Direct Mode**
Input: Connected directly to output.
Frequency Range: 0 MHz to >350 MHz.
Impedance: Loop through characteristic impedance is 50 Ω; nonterminated capacitance ≈20 pF (no connection to output).
Output: Connected directly to input. <1 dB insertion loss up to 350 MHz. Powers up in direct mode.

**Overload Protection**
Prescale: Input disconnects when input signal exceeds +20 dBm ±5 dBm for a period of ≈0.5 s or more.

**Damage Level**
Prescale: Input may be damaged if signal level exceeds +25 dBm.
Direct: 42 V peak maximum. Maximum current is 250 mA.

**Input Attenuation**
Automatic: Up to 40 dB range.

**Low Level Indicator** — Lights when input signal is below that required for error-free counting.

**Tracking Generator Compatibility** — Outputs will drive two standard TTL loads. Inputs represent two standard TTL loads. Requires arming input to associated counter.

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**DP 501** Digital Prescaler ..... **$525**

## GPIB IEEE-488 DM 5010

The DM 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**4 1/2 Digit, Autoranging**

**Dc Volts, Ohms, True RMS (ac or ac+dc)**

**Diode Test**

**Comprehensive Math Functions:**

- **dB Calculations**
- **Averaging**
- **Offset**
- **Scaling**
- **Hi/Lo/Pass**

The DM 5010 Programmable Digital Multimeter measures dc voltage, resistance, true RMS ac voltage, and true RMS ac+dc voltage. The internal math capability of the DM 5010 provides most of the calculations normally required for reducing raw measurements to decision-supporting information without controller assistance. These calculations include averaging (up to 19,999 measurements), offset and scaling, conversion to dBm or reference dB, and Hi/Lo/Pass comparisons. User-selectable constants required for calculations may be supplied either through the front-panel keypad or via the GPIB.

The internal math capability of the DM 5010 permits such specialized measurements as: ac or dc current measurements, through the use of an external shunt resistor and a scaling factor equal to the ohmic value of the resistor; comparison against a percent tolerance (as opposed to an absolute value tolerance) through the combined use of the scaling and Hi/Lo/Pass functions.

**Refer to DMM Selection Guide on Page 378.**

The low voltage (0.2 volt) ohms function allows in-circuit resistance measurements without turning on parallel diode and transistor junctions. A Diode Test function is provided for forward and reverse testing of diode and transistor junctions.

The versatile TM 5000 rear interfacing capability allows signals to be applied to the DM 5010 via the rear interface connector as well as via the front panel input jacks. This front-rear selection capability allows the rapid comparison of two signals or voltage levels, such as the input and the output of a device, without the need for external switching of the signal. Selection of front or rear signal input may be made under bus control or by front-panel pushbutton.

The DM 5010 is fully guarded, with the Guard connector automatically connected to the Low input when there is no Guard signal lead inserted.

The Null function eliminates much of the requirement for four-wire ohms connections by allowing the operator, or the system, to null out lead resistance in resistance measurements. The Null function also allows the difference between two measurements to be displayed, either directly or as a dB difference.

A special Low Frequency Response function permits stable readouts of low frequency ac voltages.

Range selection is either automatic or manually incremented. Measurements and calculations may be triggered by internal circuitry, a front-panel pushbutton, a rear interface signal, or a GPIB command.

Calibration of the DM 5010 is greatly simplified through the use of internal microprocessor-computed nonvolatile calibration constants.

## CHARACTERISTICS

### DC VOLTS

**Ranges** — 200 mV, 2 V, 20 V, 200 V, 1000 V.

**Accuracy***1

| +18°C to +28°C | Normal Conversion Rate | Fast Conversion Rate |
|---|---|---|
| 200 mV | ±[0.015% of reading +0.01% of full scale (2 counts)] | ±[0.05% of reading +0.05% of full scale (1 count)] |
| 2 V through 200 V | ±[0.015% of reading +0.005% of full scale (1 count)] | ±[0.05% of reading +0.05% of full scale (1 count)] |
| 1000 V | ±[0.020% of reading +0.010% of full scale (2 counts)] | ±[0.05% of reading +0.1% of full scale (2 counts)] |
| **0°C to 18°C, +28°C to +50°C** | **Normal Conversion Rate** | **Fast Conversion Rate** |
| 200 mV | ±[0.06% of reading +0.035% of full scale (7 counts)] | ±[0.1% of reading +0.1% of full scale (2 counts)] |
| 2 V through 200 V | ±[0.06% of reading +0.03% of full scale (6 counts)] | ±[0.1% of reading +0.1% of full scale (2 counts)] |
| 1000 V | ±[0.065% of reading +0.035% of full scale (7 counts)] | ±[0.1% of reading +0.15% of full scale (3 counts)] |

**1 Valid for six months or 1000 operating hours, whichever occurs first.*

**Common-Mode Rejection Ratio (With 1 kΩ Imbalance)** — Unguarded: ⩾130 dB at dc. ⩾80 dB at 50 Hz to 60 Hz. Guarded: ⩾140 dB at dc. ⩾100 dB at 50 Hz to 60 Hz.

**Normal-Mode Rejection Ratio** — ⩾40 dB at 50 Hz or 60 Hz ±0.2 Hz.

**Maximum Resolution** — 10 μV.

**Step Response Time (To Rated Accuracy)**
Run Mode: Normal conversion rate is ⩽0.53 s.
Fast conversion rate is ⩽0.08 s.
Triggered Mode: Normal conversion rate is ⩽0.33 s.
Fast conversion rate is ⩽0.06 s.

**Input Resistance** — 200 mV to 20 V Range: >$10^9$ Ω.
200 V to 1000 V Range: 10 MΩ ±0.25%.

**Maximum Input Voltage** — 1000 V peak.

### TRUE RMS AC VOLTS (ACV AND AC+DC)

**Input Signal** — Must be between 5% and 100% of full scale.

**Ranges** — 200 mV, 2 V, 20 V, 200 V, 700 V.

**Accuracy***1

| +18°C to +28°C | Normal and Fast Conversion | | |
|---|---|---|---|
| **Voltage Ranges** | **20 Hz to 100 Hz** | **100 Hz to 20 kHz** | **20 kHz to 100 kHz** |
| 200 mV through 200 V | ±(0.8% of rdg +0.2% of full scale) | ±(0.2% of rdg +0.2% of full scale) | ±(1.0% of rdg +0.5% of full scale) |
| 700 V (15 kHz maximum) | ±(0.8% of rdg +0.6% of full scale) | ±(0.2% of rdg +0.6% of full scale) | |
| **0°C to +18°C, +28°C to +50°C** | **Normal and Fast Conversion** | | |
| 200 mV through 200 V | ±(1.25% of rdg +0.35% of full scale) | ±(0.65% of rdg +0.3% of full scale) | ±(1.45% of rdg +0.65% of full scale) |
| 700 V (15 kHz maximum) | ±(1.25% of rdg +0.95% of full scale) | ±(0.65% of rdg +0.95% of full scale) | |

**Ac Volts + Dc Volts Only**

| +18°C to +28°C | Normal and Fast Conversion Rate; 10Hz to 20 Hz |
|---|---|
| 200 mV through 200 V | ±(0.8% of rdg +0.3% of full scale) |
| 700 V | ±(0.8% of rdg +0.9% of full scale) |
| **0°C to +18°C, +28°C to +50°C** | **Normal and Fast Conversion Rate; 10Hz to 20 Hz** |
| 200 mV through 200 V | ±(1.25% of rdg + 0.45% of full scale) |
| 700 V | ±(1.25% of rdg + 1.25% of full scale) |

**1 Valid for a period of six months or 1000 hours, whichever occurs first.*

**Common-Mode Rejection Ratio** — Unguarded: Typically ⩾80 dB from dc to 60 Hz. Guarded: Typically ⩾100 dB from dc to 60 Hz.

**Maximum Resolution** — 10 μV.

**Response Time** — <1.2 s (except for Low Frequency Response mode).

**Input Impedance** — 2 MΩ ±0.1% paralleled by <150 pF.

**Maximum Input Voltage** — 1000 V peak ac, 500 V dc.

**Crest Factor** — Four (subject to maximum peak input voltage).

### DIODE TEST

**Operation** — A 1 mA current is generated and the resultant voltage is measured on the 2 V dc range. This produces a voltage sufficient to turn on diode and transistor junctions.

### RESISTANCE

**Ranges** — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ.

**Accuracy***1

+18°C to +28°C

| Resistance Range | Normal Conversion Rate | Fast Conversion Rate |
|---|---|---|
| 200 Ω | ±[0.015% of reading +0.015% of full scale (3 counts)] (using null)*2 | ±[0.05% of reading +0.05% of full scale (1 count)] (using null)*2 |
| 2 kΩ to 200 kΩ | ±[0.015% of reading +0.01% of full scale (2 counts)] (using null on 2 kΩ only)*2 | ±[0.05% of reading +0.05% of full scale (1 count)] |
| 2 MΩ | ±[0.10% of reading +0.01% of full scale (2 counts)] | ±[0.10% of reading +0.05% of full scale (1 count)] |
| 20 MΩ | ±[0.15% of reading +0.005% of full scale (1 count)] | ±[1.0% of reading +0.05% of full scale (1 count)] |

**Accuracy***1

0°C to +18°C, +28°C to +50°C

| Resistance Range | Normal Conversion Rate | Fast Conversion Rate |
|---|---|---|
| 200 Ω | ±[0.06% of reading +0.06% of full scale (12 counts)] (using null)*2 | ±[0.1% of reading +0.1% of full scale (2 counts)] (using null)*2 |
| 2 kΩ to 200 kΩ | ±[0.06% of reading +0.035% of full scale (7 counts)] (using null on 2 kΩ only)*2 | ±[0.1% of reading +0.1% of full scale (2 counts)] |
| 2 MΩ | ±[0.54% of reading +0.035 of full scale (7 counts)] | ±[0.55% of reading +0.1% of full scale (2 counts)] |
| 20 MΩ | ±[0.9% of reading +0.01% of full scale (2 counts)] | ±[1.6% of reading +0.05% of full scale (1 count)] |

**1 Valid for a period of six months or 1000 hours, whichever occurs first.*

**2 When the null function is not used add ±0.2 Ω to all readings.*

**Maximum Resolution** — 10 mΩ.

**Step Response Time (To Rated Accuracy)**
Run Mode: Normal conversion rate is ⩽1.24 s.
Fast conversion rate is ⩽0.33 s.
Triggered Mode: Normal conversion rate is ⩽0.73 s.
Fast conversion rate is ⩽0.19 s.

**Maximum Input Volts** — 400 V peak.

**Maximum Open Circuit Voltage Developed** — <5 V.

### OTHER CHARACTERISTICS

**Overrange Indication** — For Ohms and Diode Test, "OC" is displayed; for ACV, DCV, ACV+DCV, the display blinks.

**Measurement Rate** — ACV, DCV, ACV+DCV, Diode Test: 3/s at 4.5 digits; 26/s at 3.5 digits. Ohms: 1.6/s at 4.5 digits; 7.1/s at 3.5 digits.

**Power Consumption** — ≈20 VA.

**IEEE Standard 488-1978 Interface Function Subsets Implemented** — SH1, AH1, T5, L4, SR1, RL1, PPØ, DC1, DT1, CØ.

### INCLUDED ACCESSORIES

One set test leads (003-0120-00); instruction manual, instrument interfacing guide.

## ORDERING INFORMATION

**DM 5010** Programmable Digital Multimeter ..... **$2,210**

**Utility Software**
For TM 5000/4041 Order 062-6958-01 ..... **$150**
For TM 5000/4052A Order 062-6957-01 ..... **$150**
Refer to page 323 for description and ordering information.

### OPTIONAL ACCESSORIES

**Test Lead** — Black, 4 ft. Order 012-0425-00 ..... **$12**

**Test Lead** — Red, 4 ft. Order 012-0426-00 ..... **$22**

**Test Lead** — Black, 4 ft. Order 012-0426-01 ..... **$22**

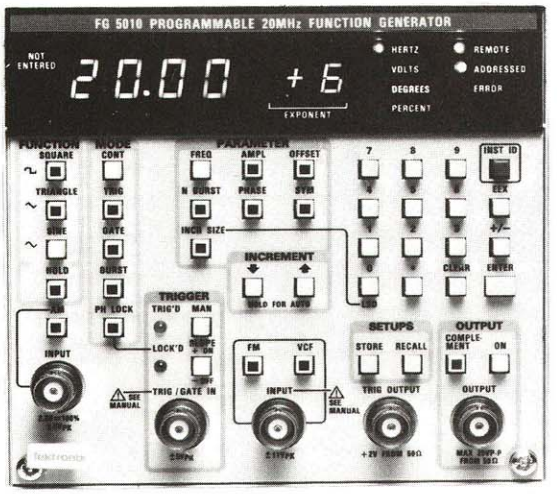
**Test Lead Set** — Includes 012-0425-00, 012-0426-00, and 013-0107-03. Order 012-0427-00 ..... **$29**

**High Voltage Probe** — To 40 kV (complete information page 380). Order 010-0277-00 ..... **$165**

**P6420 RF Probe** — 2 m cable included (complete information page 445). Order 010-6420-03 ..... **$145**

**Female BNC to Dual Banana Adaptor** — Order 103-0090-00 ..... **$7.50**

**FG 5010**




**Programmable 20 MHz Function Generator**

## GPIB IEEE-488 FG 5010

The FG 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**0.002 Hz to 20 MHz**

**Up to 20 V p-p from 50 Ohms**

**Sine, Square, Triangle, Pulse, and Ramp Waveforms**

**10 ns Rise/Fall**

**10% to 90% Variable Symmetry in 1% Steps**

**Trigger, Gate, Counted Burst**

**Phase Lock, with Autoscan**

**AM, FM, VCF**

**Waveform Complement**

The FG 5010 Programmable 20 MHz Function Generator is a highly versatile GPIB programmable instrument and also extremely easy to operate in the manual mode as well. All functions are addressable via the lighted front-panel pushbuttons with nomenclature and functionality clearly designated. The ability to store ten complete front panel setups and recall them with only two keystrokes or by a single command over the GPIB reduces GPIB programming time and enhances stand-alone bench applications.

The FG 5010 provides the conventional sine, square, triangle, pulse, and ramp waveforms. Variable symmetry, which is usable throughout the entire frequency range, extends pulse and ramp capabilities beyond those of conventional generators. The FG 5010 also provides trigger, gate, counted burst, phase lock, AM, FM, and VCF modes. Variable phase enhances the trigger, gate, burst, and phase lock modes.

The wide frequency range assures its usefulness in radio and other communication-oriented applications as well as in low frequency applications, such as biological, geophysical, and mechanical simulations.

The FG 5010 maintains frequency accuracy within 0.1% over its full 0.002 Hz to 20 MHz frequency range. Automatic phase lock to an external signal is possible from 20 Hz to 20 MHz. Waveform complement and +/− trigger slope allow interfacing to circuits with the proper waveform phase, especially important in pulse and digital applications. Waveform hold can freeze the output voltage of any 200 Hz or less waveform at its instantaneous value. With the output amplitude set to zero volts, the dc offset can be programmed to provide a dc voltage source of 0 volts to ±7.5 volts in 10 mV steps.

## CHARACTERISTICS

**Waveform** — Sine, Square and Triangle with variable Symmetry providing Pulses and Ramps.

**Symmetry** — 10% to 90%, 1% steps, ±2% accuracy. Range above 4 MHz is limited by 25 ns minimum triangle transition time (decreases to 50% at 20 MHz).

**Frequency** — Range: 0.002 Hz to 20 MHz. Accuracy: Continuous mode, ±0.1%. Trigger, Gate, Burst Modes: Frequency ≤200 Hz, ±0.1%; frequency >200 Hz, ±5.0%. Resolution: Continuous mode, 4 digits, Trigger, Gate, Burst modes. Frequency ≤200 Hz, 4 digits. Frequency >200 Hz, 3 digits.

**Amplitude** — Range: 20 mV to 20 V p-p from 50 Ω into open circuit.

**Accuracies**[*1]

| Frequency | Sine | Square | Triangle |
|---|---|---|---|
| 0.002 Hz to 1 kHz | ±3% | ±2% | ±2% |
| 1 kHz to 100 kHz | — | — | ±3.5% |
| 1 kHz to 1 MHz | ±3.5% | ±3.5% | — |
| 100 kHz to 1 MHz | — | — | ±4% |
| 1 MHz to 5 MHz | ±5% | — | +4%, −5% |
| 1 MHz to 10 MHz | — | ±5% | — |
| 5 MHz to 20 MHz | ±5%, −10% | — | +4%, −20% |
| 10 MHz to 20 MHz | — | ±10% | — |

*[*1] Measured at +25° C ±10° C into 50 Ω load at 50% symmetry. Resolution: 20 mV from 2.02 V to 20.00 V p-p, 2 mV from 202 mV to 2.000 V p-p, 0.2 mV from 20.0 mV to 200.0 mV p-p.*

**Offset** — Range: −7.5 V to +7.5 V from 50 Ω into an open circuit. Maximum peak signal plus offset cannot exceed ±15 V open circuit, Accuracy: All waveforms except squarewave >2 MHz ≤ ±(1% of the selected offset, + 2% of the signal p-p amplitude, +20 mV). Squarewave >2 MHz <±(1% of the selected value +5% of the signal p-p amplitude +20 mV). Resolution: 10 mV open circuit, 5 mV into 50 Ω load. 0 V is also provided.

**Output Impedance** — 50 Ω.

**Sinewave Distortion** — 20 Hz to 19.99 kHz, ≤0.5%; 20.0 kHz to 99.99 kHz, ≤1.0%; 100 kHz to 20.0 MHz, harmonics >30 dB down from 100 kHz to 20 MHz. Valid from +15°C to +35°C into 50 Ω load with 0 V offset, continuous mode, 50% symmetry, and AM, FM, VCF, and Complement off.

**Squarewave Response** — Risetime and falltime are ≤10 ns. Aberrations are ≤5% p-p +20 mV.

**Typical Triangle Linearity (10% to 90%)** — 0.002 Hz to 200 Hz, ≤1%; 200 Hz to 100 kHz, ≤1%; 100 kHz to 2 MHz, ≤2%; 2 MHz to 20 MHz, ≤10%.

**Trigger Output** — 0 V ±100 mV to ≥+2 V from 50 Ω source impedance into an open circuit.

### TRIG, GATE, BURST, AND PH LOCK INPUT

**Input Impedance** — 1 MΩ or 50 Ω, internally selectable.
**Trigger Threshold** — 0 V or + 0.5 V, internally selectable.
**Amplitude Sensitivity** — ≤250 mV p-p.
**Slope** — Plus or minus, plus only in Ph Lock.
**Minimum Pulse Width** — 25 ns.
**Maximum Frequency** — 20 MHz.
**Maximum Input Amplitude** — ±5 V peak into 50 Ω, ±20 V peak into 1 MΩ.
**Burst Range** — 1 cycle to 9999 cycles.
**Phase Lock Range** — Automatic capture from 20 Hz to 20 MHz.
**Phase Lock Time** — Typically 8 ms to 88 s, depending on final frequency and start frequency.

### AM INPUT

**Input Impedance** — 10 kΩ (±5% when AM is selected).
**Sensitivity** — 5 V p-p produces ≥100% modulation.
**Distortion** — <2% at 70% modulation and ≤2 MHz; <4% at 70% modulation and >20 MHz.
**Bandwidth** — Dc to ≥100 kHz.
**Maximum Input Amplitude** — ±20 V pk.

### FM INPUT

**Input Impedance** — 10 kΩ.
**Sensitivity** — 0 V to ±1 V modulates to ≥±1% deviation from center frequency.
**Distortion** — ≤2%.
**Bandwidth** — Dc to ≥100 kHz.
**Maximum Input** — ±20 V peak.

### VCF INPUT

**Input Impedance** — 10 kΩ ±5%.
**Sensitivity** — 0 V to 10.0 V produces a ≥1000:1 frequency change, positive going voltage increases frequency.
**Slew Rate** — ≥0.063 V/μs.
**Bandwidth** — Dc to ≥100 kHz.
**Maximum Input** — ±20 V peak.

### OUTPUT HOLD MODE

**Range** — 0.002 Hz to 200 Hz. (Output holds at instantaneous value).

### PHASE (TRIG, GATE, AND BURST MODES)

**Range** — ≤90° to 1 MHz, decreasing to ≤80° at 20 MHz.
**Accuracy** —
±3° to 500 kHz; $\pm[7° + (\frac{\text{freq}}{20\text{ MHz}} \times 28\% \times |\Phi|)°]$ for freq >500 kHz
At 25 ±10°C VCF off, output in Normal and symmetry at 50%.
**Resolution** — 1°.

### PHASE (PH LOCK MODE)

**At 25 ±10°C.**
**Range** — ≤90°, 20 Hz to ≤10 MHz; ≤45° to ≥10 MHz (Complementing the output extends effective 0 range to ±180°).
**Accuracy** — ±(2° +5% of selected value).
**Resolution** — 1°.
**IEEE Standard 488-1978 Interface Function Subsets Implemented** — SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0.

### OTHER CHARACTERISTICS

**Power Consumption** — 60 W.

### INCLUDED ACCESSORIES

Instruction manual; reference guide, instrument interfacing guide.

## ORDERING INFORMATION

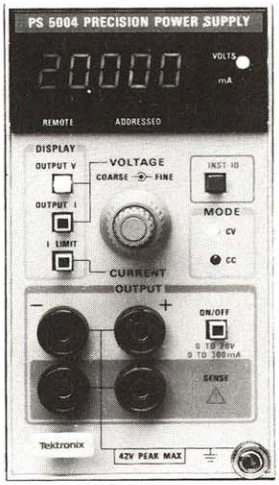
**FG 5010** 20 MHz Function Generator . **$4,400**

**Utility Software**
For TM 5000/4041 Order 062-6958-01 ..... **$150**
For TM 5000/4052A Order 062-6957-01 ..... **$150**
Refer to page 323 for description and ordering information.

### OPTIONAL ACCESSORIES

**Rear Interface Signal Cable Kit** — Order 020-0701-00 . **$35**
**Service Kit** — Order 067-1041-00 ..... **$280**

**PS 5004**




**Programmable Precision Power Supply**

## GPIB IEEE-488 PS 5004

The PS 5004 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**0 V to 20 V Floating Output**

**0.01% Accuracy**

**500 μV/0.1 mA Resolution**

**Constant Voltage or Constant Current with Autocrossover**

**Voltage and/or Current Monitoring Display**

**Remote Sensing**

The single-width PS 5004 Precision Power Supply provides the high-resolution voltages and currents necessary in the characterization of transistor, IC, and other semiconductor and hybrid circuits and in the operation of high-performance strain gages and other transducer systems. Its entire 0 V to 20 V output is covered with a coarse and fine adjustment to provide rapid setability and ±500 μV resolution without the necessity of changing ranges. Setability resolution over the GPIB is also ±500 μV. The supply output is available at the rear interface as well as from the front panel terminals. Overall accuracy is ±0.01% ±2 mV.

The PS 5004 operates in either a constant voltage or constant current mode with autocrossover between the two. Front panel annuciators indicate the mode at all times. The operating mode is also reported over the bus and the PS 5004 may be programmed to assert SRQ whenever operating conditions cause it to change from one mode to the other.

The 4½ digit display shows actual output voltage, selected current limit, or actual output current. The actual output voltage is shown even when the PS 5004 is operating in the current-limited or unregulated mode. Display resolution is 1 mV or 0.1 mA.

The buffered high-impedance sense terminals allow proper regulation of the supply with up to 3 Ω of resistance in either of the sense leads.

### CHARACTERISTICS

#### CONSTANT VOLTAGE MODE

**Range** — 0 V to 20 V in 0.5 mV steps.

**Overall Accuracy (Total Effect)** — ±0.01% +2 mV from +15°C to +30°C, derating to ±0.035% +3 mV at 0°C and +50°C.

**Source Effect** — 500 μV.

**Load Effect** — 1 mV for a no load to full load change in load current measured at sense terminals.

**Step Size Accuracy** — 0.5 mV ±0.2 mV.

**PARD**[*1] — ≤2 mV p-p, 10 Hz to 5 MHz.

**Load Transient Recovery**[*1 *2] — <200 μs to recover within 5.0 mV of final value for a 100 mA load change.

*[*1] Characteristics measured at front panel terminals without using remote sense.*

*[*2] Without external energy storage components.*

#### CONSTANT CURRENT MODE

**Range** — 10 mA to 305 mA in 2.5 mA steps.

**Overall Accuracy** — ±2% +5 mA.

#### DIGITAL METER

**Configuration** — True 4½ digit free running voltmeter. Meter can be selected by front panel controls or via GPIB to monitor output voltage, current or current limit setting. Measurements are displayed on the front panel and are available over the GPIB.

**Resolution** — 1 mV or 0.1 mA.

**Accuracy** — Output Voltage: ±0.15% +6 mV. Output Current: ±1.5% +1 mA. Current Limit: ±1.5% +5 mA.

**Reading Rate** — ≈5/s.

**IEEE Standard 488-1978 Interface Function Subsets Implemented** — SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0.

#### OTHER CHARACTERISTICS

**Isolation Voltage (Maximum Allowable Voltage Between Any Output or Sense Terminal and Chassis Ground)** — 42 V peak ac + dc.

**TM 5000 Power Module Compatibility** — The PS 5004 is not compatible with TM 500 mainframes.

#### INCLUDED ACCESSORIES

Instruction manual; reference guide.

### ORDERING INFORMATION

**PS 5004** Precision Power Supply ..... **$1,785**

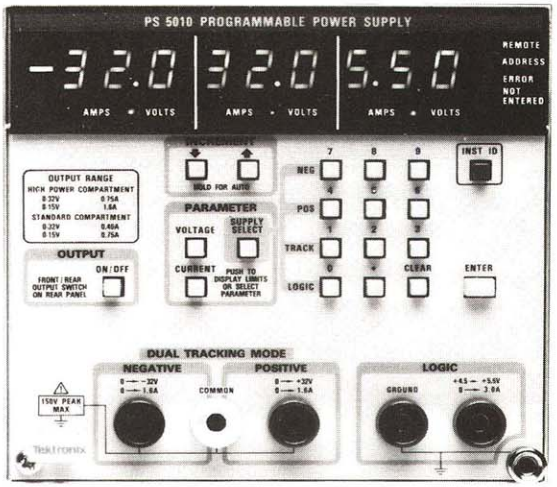
**Utility Software**

For TM 5000/4041 Order 062-6958-01 ..... **$150**

For TM 5000/4052A Order 062-6957-01 ..... **$150**

Refer to page 323 for description and ordering information.

**PS 5010**




**Programmable Triple Power Supply**

## GPIB IEEE-488 PS 5010

The PS 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**Dual Floating Supplies 0 V to 32 V, to 0.75 A (1.6 A to 15 V)**

**Logic Supply +4.5 V to 5.5 V, to 3 A**

**0.5% Accuracy**

**Programmable Current Limits**

**Three Independent Digital Displays**

**Automatic Crossover**

The PS 5010 Programmable Power Supply provides a complete and rapid high performance solution for many system power supply applications. Its three supplies provide the most commonly used voltages, and the three digital displays automatically indicate all six voltage and current limit parameters. Automatic crossover from voltage to current limit and a powerful set of GPIB status reporting messages allow the user to be constantly aware of the PS 5010's status.

The PS 5010's dual floating supply provides 0 V to +32 V and 0 V to −32 V, both with respect to a common front-panel terminal. Or 0 V to 64 V across the terminals of both supplies together—with currents up to 0.75 A throughout the total voltage range and 1.6 A below 15 V. The logic supply provides +4.5 V to +5.5 V with respect to ground, with currents to 3 A. The user can program the outputs on and off, and can lock out the front panel controls with GPIB commands.

The three supplies can be independently programmed for separate voltage and current limits, and displayed in the LED display. Whenever a load change causes a supply to change modes from constant voltage to constant current (or vice versa), the corresponding display also changes to show the known current or voltage value. This condition can be reported over the GPIB via an interrupt when the PS 5010 is in the remote state.

## CHARACTERISTICS

### POSITIVE AND NEGATIVE FLOATING SUPPLIES

**Configuration** — Dual floating with shared common terminal.

**Isolation** — 150 V peak front panel, 42 V peak from rear interface, 0.015 μF typical shunt capacitance to ground.

**Voltage Range** — 0 V to +32.0 V; 0 V to −32.0 V.

**Voltage Accuracy** — ±(0.5% + 20 mV) overall; ± (0.01% +2 mV) line regulation; ±10 mV for 1 A load current change (1 mV when using rear interface output with remote sensing).

**Voltage PARD (Ripple and Noise)** — 10 mV p-p; 20 Hz to 20 MHz.

**Voltage Resolution** — 10 mV ±10 mV (typically ±2 mV) to 10.0 V. 100 mV ±40 mV (typically ±10 mV) >10.0 V.

**Load Transient Recovery** — 500 μs to recover within 20 mV of nominal value for a 1 A change.

**Voltage Change Response Time** — 1 ms for up or down change with maximum load, 20 ms for down change with no load.

**Current Range** — 50 mA to 0.75 A (1.60 A at 15 V and below) in high power compartment; 50 mA to 400 mA (0.750 A at 15 V and below) in two standard power compartments.

**Current Accuracy** — ±(5% + 20 mA) overall; ±1 mA line regulation; ±10 mA load regulation. Output impedance is typically 5 kΩ shunted by 20 μF.

**Current Mode PARD (Ripple and Noise)** — 10 mA p-p, 20 Hz to 20 MHz.

**Current Change Response Time** — 20 ms up or down.

**Current Resolution** — 50 mA ±15 mA.

### LOGIC SUPPLY

**Voltage Range** — +4.50 V to +5.50 V, ground referenced.

**Voltage Accuracy** — ±50 mV overall; ±1 mV line regulation; ±10 mV for 1 A load current change (1 mV when using rear interface output with remote sensing).

**Voltage PARD (Ripple and Noise)** — 10 mV p-p, 20 Hz to 20 MHz.

**Voltage Resolution** — 10 mV ±10 mV (typically ±2 mV).

**Load Transient Recovery** — 500 μs to recover within 20 mV of nominal value.

**Current Limit Range** — 100 mA to 3.0 A (Foldback characteristic below 4.5 V, maximum short circuit current is <1.5 A).

**Current Limit Accuracy** — ±(5% +20 mA).

**Current Resolution** — 100 mA ±30 mA.

**Scaled Current Output** — 10 mA = 1 mV ±(2% +2 mV) available at rear interface (not ground referenced).

**Overvoltage Protection** — SCR crowbar typically trips at 6 V to 7 V.

### OTHER CHARACTERISTICS

**TM 5000 Power Module Compatibility** — The PS 5010 is not compatible with TM 500 mainframes.

**Power Consumption** — 250 VA maximum in high power compartment, 200 VA in standard compartment.

**Included Accessories** — Instruction manual; reference guide.

## ORDERING INFORMATION

**PS 5010** Power Supply ..... **$2,990**

**Utility Software**

For TM 5000/4041 Order 062-6958-01 ..... **$150**

For TM 5000/4052 Order 062-6957-01 ..... **$150**

Refer to page 323 for description and ordering information.

**SG 5010/AA 5001**

**Programmable Audio Test System**

GPIB IEEE-488

# SG 5010/AA 5001

The SG 5010 and AA 5001 comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**Fast, Accurate, Repeatable Measurements**

**Lower Required Operator Skill**

**Automatic Low-Cost Documentation of Test Results**

### Automated Audio Test System Advantages

Tektronix SG 5010 and AA 5001 programmable instruments in a computer-controlled test system will make critical audio measurements consistently, accurately, and in two to four seconds each. Even complex tests can be made by technically unskilled operators since the procedures are controlled by software in the controller. And, permanent graphic or tabular records of test results can be produced at very low cost.

An SG 5010/AA 5001 based system will automatically perform such industry-standard tests as harmonic distortion to IHF A202, intermodulation distortion to SMPTE TH 22.51, DIN 45403, IEC 268.3, and IHF A202, frequency response to IHF A202, and noise or signal-to-noise ratio to IHF A202 ("A" weighting filter complies with ANSI specification S1.4 and IEC specification 179 for sound level meters). With the Option 02 capability of the AA 5001, noise measurements may be made to CCIR 468-2 and DIN 45405 standards. The SG 5010 also generates the burst signal necessary for dynamic headroom tests per IHF A202.

A basic automated system consists of the SG 5010 Programmable Oscillator, the AA 5001 Programmable Distortion Analyzer, and an IEEE Standard 488 controller such as the Tektronix 4041 System Controller. Frequency counters, signal switchers, interface devices, disc storage, and hard copy units or plotters may be optionally added to the system.

### Typical Applications

One ideal application for automated audio testing is the moderate-to-high volume production line for consumer and professional audio equipment. Test results can be economically logged or printed for files or the customer. In the engineering laboratory, characterization of complex variable devices such as parametric equalizers can be greatly speeded with automatic test equipment, and the Tektronix 4695 Color Graphics Copier can quickly produce highly legible results. Audio tape recorders and the audio channels of video tape, cassette, and disc machines may be tested with no special synchronization required, as can earth stations and radio networks when a stepped tone signal is available. Performance levels of the SG 5010/AA 5001 system are consistent with new 16-bit digital system noise and distortion levels. Radio and TV broadcasting stations and networks can automate proof-of-performance tests, even running them daily at sign-on or sign-off to maintain signal quality control. Highly complex devices, such as large recording consoles with multiple inputs and outputs or large audio switchers, may be impractical to test with manual techniques and truly maintainable only via automation. Loudspeakers and microphones can be automatically characterized by the addition of reference transducers and pre-amplifiers to the system. Swept pre-emphasis, de-emphasis, or equalized signals can be easily generated since the controller has full control over both frequency and amplitude.

### Other Measurement Capabilities

Features and flexibility of the SG 5010 and AA 5001 permit a variety of other measurements to be easily automated. SMPTE-like IMD measurements may be made at a variety of lower frequencies and any value of upper frequency, and at 1:1 amplitude ratios in addition to the standard 4:1 ratio. A CCIF test with the frequencies selected near the upper band limit of the device under test has been shown to be a very effective and simple-to-implement test for transient or dynamic intermodulation (TIM and DIM). Burst signals of any desired duty cycle may be generated for IHF dynamic headroom measurements and to test

compressors and limiters; the between-bursts level may be selected as Off or 20 dB below the burst level. Power measurements are made by a controller computation from a voltage measurement across a known load resistance. SINAD measurements of sensitivity of FM communications receivers are a standard capability of the AA 5001 plus an appropriate RF signal generator. The SG 5010 features an amplifier mode in which an external signal can be converted to the high level, multiple impedance, balanced and floating capability of the SG 5010 output circuitry. Fully program-selectable filters in the AA 5001 allow various choices of bandwidth for distortion measurements and weighting for noise measurements, or rejection of interfering signals. Phase measurements can be added to the system by use of the DC 5009 or DC 5010 Universal Counter-Timer.

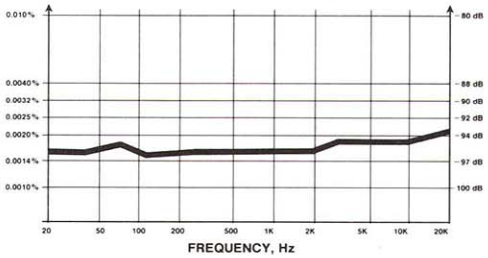
## SYSTEM CHARACTERISTICS

### HARMONIC DISTORTION FUNCTION

**Measurement Settling Time** — Typically ≤2.5 s above 100 Hz, increasing by 1 s/octave below 100 Hz.
**Residual THD + N** — $V_{in}$ ≥250 mV, RMS response, all distortion, noise, and nulling resources combined. 20 Hz to 20 kHz ≤0.0032% (−90 dB) with 80 kHz filter. 10 Hz to 100 kHz ≤0.01% (−80 dB) no filters.

### TYPICAL SYSTEM RESIDUAL THD + NOISE

$V_{in}$ ≥250 mV with 80 kHz filter, RMS response.




### INTERMODULATION DISTORTION FUNCTION

**Measurement Settling Time** — Typically ≤2 s.
**Residual IMD** — $V_{in}$ ≥250 mV, RMS response.
**SMPTE and DIN Tests** — ≤0.0032% (−90 dB) for 60 Hz and 7 kHz or 250 Hz and 8 kHz, 4:1 ratio.
**CCIF Difference Frequency Test** — ≤0.0018% (−95 dB) with 14 kHz and 15 kHz.

### LEVEL FUNCTION

**Measurement Settling Time** — Typically ≤2 s.
**Flatness** — ±0.1 dB 20 Hz to 20 kHz.

## SG 5010 CHARACTERISTICS

### VAILABLE FUNCTIONS

Sinewave, squarewave, SMPTE/DIN 4:1, SMPTE/DIN 1:1, CCIF, Sinewave Burst, IHF Burst (−20 dB or Off between bursts), External Input (Amplifier Mode).

### FREQUENCY RANGE AND ACCURACY

**Sinewave, Sinewave Burst**
SMPTE/DIN: 10 Hz to 163.80 kHz ±0.01%.
CCIF Center Frequency: 2.500 kHz to 163.80 kHz ±0.01%.
Squarewave: 10 Hz to 16.380 kHz ±0.01%.
**Resolution in Above Functions**
10.00 Hz to 163.80 Hz: 0.01 Hz. 163.9 Hz to 1.6380 kHz: 0.1 Hz. 1.639 kHz to 16.380 kHz: 1.0 Hz. 16.39 kHz to 163.80 kHz: 10.0 Hz.
**SMPTE Lower Tone, CCIF Offset From Center Frequency** — Selectable From: 40 Hz, 50 Hz, 60 Hz, 80 Hz, 100 Hz, 125 Hz, 250 Hz, 500 Hz, all ±2%.
**Sine Distortion (Load ≥600 Ω, THD Including 2nd Through 5th Harmonics)** — 20 Hz to 20 kHz: 0.001% (−100 dB). 20 kHz to 50 kHz: 0.0032% (−90 dB). 10 Hz to 20 Hz and 50 kHz to 100 kHz: 0.01% (−80 dB). 100 kHz to 163.8 kHz: 0.032% (−70 dB) any individual harmonic.
**SMPTE, DIN or CCIF Distortion** — See System Specifications.
**Sine Flatness** — 20 Hz to 20 kHz: ±0.05 dB. 10 Hz to 163.8 kHz: ±0.2 dB.
**Squarewave Risetime** — 1.5 μs ±10%.
**Burst Range** — 1 cycle to 65535 cycles On. 1 cycle to 65535 cycles Off. Off level either −20 dB or zero. All switching at sinewave zero crossing. Triggered, gated, or free-running burst modes available.

### OUTPUT LEVEL RANGE AND ACCURACY

**Balanced** — Into Open Circuit: 200 μV to 21.2 V RMS. Into 600 Ω: −72.45 dBm to +28.05 dBm.*1
**Unbalanced** — Into Open Circuit: 200 μV to 21.2 V RMS. Into 600 Ω: −72.45 dBm to +22.05 dBm.*1
**Resolution** — 0.05 dB in dBm mode, 0.25% or better in volts mode.
**Level Accuracy (Sinewave)** — 20 Hz to 20 kHz ±2% (0.2 dB). 10 Hz to 163.8 kHz ±3 (0.3 dB).
*1 *$R_S$ = 50 Ω. For $R_S$ = 150 Ω, subtract 1.25 dBm; for $R_S$ = 600 Ω, subtract 5.35 dBm.*

### OUTPUT IMPEDANCE AND CONFIGURATION

50 Ω ±3%, 150 Ω ±2%, or 600 Ω ±1%, balanced or unbalanced, floating or grounded.

### EXTERNAL INPUT

A floating single-ended input is provided for accessing the variable gain stage and high level output amplifier, enabling the use of custom test signals. Input impedance is 20 kΩ; a 2 V RMS input (2.83 V peak maximum) provides a calibrated output.

### SYNC OUTPUT

A ground referenced TTL compatible signal is provided which allows stable oscilloscope display of all functions. In sine and squarewave modes the output is at the signal frequency. In the IM modes the sync output is at the lower or offset frequency. In both burst modes the sync signal follows the burst envelope.

### SWEEP MODE

Linear or logarithmic sweep of amplitude or frequency in any function. Sweep is composed of discrete steps. The following sweep functions are programmable via GPIB or from the front panel: swept parameter (frequency or amplitude), linear or log sweep, number of steps up to 99, time per step from 0.1 s to 25 s, start frequency or voltage, and stop frequency or voltage. Start and stop frequencies or voltages may be anywhere within the range of the generator, and sweep direction may be upward or downward. Pen lift and ramp outputs are available for interface to an analog plotter.

### STORED SETUPS

Ten different complete front panel setups may be stored in the nonvolatile internal memory and recalled from front panel push buttons or via the GPIB. Additionally, the front panel settings at power down are retained and used at power up.

### PROGRAMMABILITY

All functions, parameters, and modes may be controlled over the GPIB using simple English-like commands. All settings may be interrogated, with the resulting response usable as a command to return the instrument to that setting (Learn mode). The GPIB address may be displayed and changed from the front panel.
**GPIB Interface Function Subsets Implemented** — SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0.

## AA 5001 CHARACTERISTICS

### HARMONIC DISTORTION FUNCTION

**Fundamental Frequency Range** — 10 Hz to 100 kHz, automatically tuned to input frequency.
**Distortion Ranges** — Auto (100%), 20%, 2%, 0.2%, and dB (autoranging).
**Accuracy** — 20 Hz to 20 kHz is ±1 dB. 10 Hz to 100 kHz is +1, −2 dB. (Accuracy is limited by residual THD + N and filter selection.)
**Fundamental Rejection** — At least 10 dB below specified residual THD + N or actual signal THD, whichever is greater.
**Minimum Input Level** — 60 mV (−22 dBm).

### LEVEL FUNCTION

Autoranging digital voltmeter displays input signal level in volts, dBm, or dB ratios.
**Modes** — Volts, dBm (600 Ω), or dB ratio with push-to-set 0 dB reference.
**Level Ranges** — 200 μV full scale to 200 V full scale in ten steps, manual or autoranging.
**Accuracy**

| Frequency | Volts | dBm or dB Ratio |
|---|---|---|
| 20 Hz to 20 kHz | ±2%<br>±1 count | ±0.3 dB*1<br>+0.5% of reading |
| 10 Hz to 100 kHz | ±4%<br>±2 counts | ±0.5 dB*1<br>+0.5% of reading |

*1 *$V_{in}$ ≥ 100 μV, level ranging indicators extinguished. ±0.2 dB at 1 kHz only. Flatness is ±0.1 dB, 20 Hz to 20 kHz, and ±0.3 dB, 10 Hz to 100 kHz.*

**Bandwidth** — ≥300 kHz.
**Residual Noise** —
≤3 μV (−108 dBm) with 80 kHz and 400 Hz filters, RMS response.
≤1.5 μV (−114 dBm) with "A" weighting filter, RMS response (standard instrument only).
≤5 μV (−104 dBm) with CCIR weighting filter, quasi-peak response (Option 02 instrument only).

### INTERMODULATION DISTORTION FUNCTION

Fully automatic SMPTE, DIN, and CCIF difference tone measurements. Minimum input level 60 mV (−22 dBm). Accuracy ±1 dB.
**SMPTE and DIN Tests** — Lower Frequency Range: 50 Hz to 500 Hz. Upper Frequency Range: Usable from 3 kHz to 163.8 kHz. Level Ratio Range: 1:1 to 4:1 (lower:upper). Residual IMD: See System Specifications.
**CCIF Difference Frequency Test** — Frequency Range: Usable from 4 kHz to 163.8 kHz. Difference Frequency Range: 80 Hz to 1 kHz. Residual IMD: See System Specifications.

### ALL FUNCTIONS

**Display** — 3½ digits resolution at ≈3 readings/s.
**Detection** — Average or true RMS for waveforms with crest factors ≤3. Option 02 replaces average detector with quasi-peak detector complying with CCIR Recommendation 468-2 and DIN 45405.
**Filters**
400 Hz High Pass: −3 dB at 400 Hz ±5%: 18 dB/octave slope, at least 40 dB rejection at 60 Hz.
80 kHz Low Pass: −3 dB at 80 kHz ±5%; 18 dB/octave slope.
Audio Bandpass: −3 dB at 22.4 Hz and 22.4 kHz, both ±5%. Complies with CCIR Recommendation 468-2 and DIN 45405.
"A" Weighting: Meets specifications for Type one sound level meters (ANSI S1.4, IEC Recommendation 179). Option 02 replaces "A" weighting filter with CCIR weighting filter complying with CCIR Recommendation 468-2 and DIN 45405.
Ext: Allows connection of external filters.
**Input Type** — Balanced (full differential).
**Input Impedance** — 100 kΩ ±2%, each side to ground.
**Maximum Input** — 300 V peak, 200 V RMS either side to ground or differentially. Fully protected on all ranges.
**Common-Mode Rejection** — ≥50 dB at 50 Hz or 60 Hz. Typically ≥40 dB to 300 kHz.

### PROGRAMMABILITY

Function (Level or THD or IMD). Level Mode (Volts or dBm). Input Level and Distortion Ranges (Autorange or default to range selected by front panel switches).
Detector Type (RMS or AVG; or RMS or Q-PK on Option 02).
Filter Selection (400 Hz Hi Pass, 80 kHz Low Pass, 22.4 Hz to 22.4 kHz Band-Pass, "A" Weight (or CCIR WTG on Option 02, Ext Filter).
**GPIB Interface Function Subsets Implemented** — SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT0, C0.

### FRONT PANEL SIGNALS

**Input Monitor** — Provides constant amplitude version of signal applied to input. Output Voltage: 1 V RMS ±10% for input signals >50 mV. Source Impedance: 1 kΩ ±5%.
**Function Output** — Provides a scaled sample of selected function signal. Output Voltage: 1 V RMS ±3% for 1000 count display. Source Impedance: 1 kΩ ±5%.
**Auxiliary Input** — Provides input to detector circuit when Ext Filter button is depressed. Sensitivity: 1 V RMS ±3% = 1000 count display. Impedance: 100 kΩ ±5%, ac coupled.

### REAR INTERFACE SIGNALS

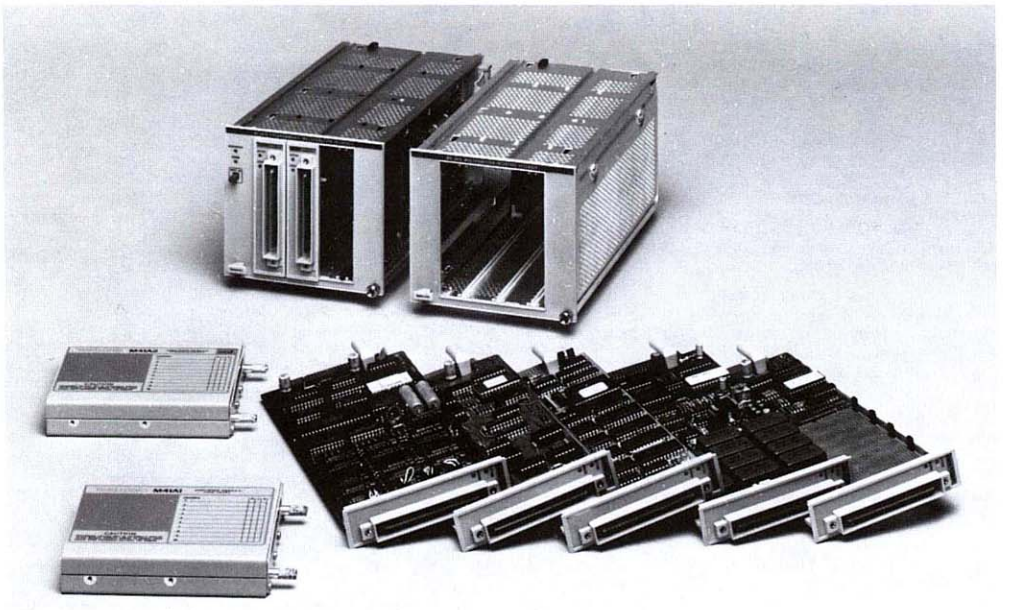
Duplicates of all front panel inputs and outputs are provided to allow external filter connections or oscilloscope monitoring within same mainframe without exposed cables. Detector outputs with specified scale factors also available to drive analog chart recorders, storage oscilloscopes, or similar devices.

### INCLUDED ACCESSORIES (SG 5010/AA 5001)

Instruction manual; reference guide; instrument interface guide.

## ORDERING INFORMATION

**SG 5010** Programmable Oscillator ..... **$4,100**
**AA 5001** Programmable Distortion Analyzer ..... **$3,365**
**Option 02** — CCIR/DIN ..... **$410**
**Utility Software**
For TM 5000/4041 Order 062-6958-01 ..... **$150**
For TM 5000/4052A Order 062-6957-01 ..... **$150**
Refer to page 323 for description and ordering information.



**Multifunction Interface System**

## GPIB IEEE-488 MI 5010/MX 5010

The MI 5010 and MX 5010 comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**Wide Range of System Interfacing Functions**

**Up to Six Functions at One Address**

**D-to-A, A-to-D Conversion**

**Low-Level Signal Scanning**

**Digital I/O**

**Digital Word Acquisition and Generation**

**Built-In Time-of-Day and Pacing Clock**

**Command Buffer for Controller-Free Operation**

**Thermocouple Scanning**

The MI 5010/MX 5010 Multifunction Interface System consists of the MI 5010 Multifunction Interface, the MX 5010 Multifunction Interface Extender, and seven different types of function cards. These cards are capable of a variety of functions typically required in automated test system interfacing, data acquisition and generation, and process control.

The MI 5010 and MX 5010 each house up to three function cards, in any combination. The MI 5010 provides the means of communication between the system controller and the function cards. The MX 5010 is always used in connection with an MI 5010, extending its control to six function cards at one GPIB address.

The function cards presently available for the MI 5010/MX 5010 Multifunction Interface System are: 50M10 Analog-to-Digital Converter, 50M20 Digital-to-Analog Converter, 50M30 Digital I/O, 50M40 Relay Scanner, 50M41 Low-Level Scanner (with M41A1 through M41A8 Signal Conditioners), 50M50 Memory, and 50M70 Development card. Each function card contains its own ROM with the specific firmware and its own unique set of commands required for its particular function. Each card may be operated in any slot of the MI 5010 and/or MX 5010 regardless of the other cards in the system.

In addition to providing the interface between the function cards and the system controller, the MI 5010 also has its own intelligence and a built-in command buffer. This buffer is capable of storing up to 300 system commands and executing them in sequence, paced by the on-board time-of-day and pacing clock or by signals from the system under test. It requires no interference from the system controller, thus freeing the controller to direct activity elsewhere in the system.

**IEEE Standard 488-1978 Interface Function Subsets Implemented** — SH1, AH1, T6, L4, SR1, RL0, PP0, DC1, DT1, C0.

**INCLUDED ACCESSORIES**

Instruction manual; reference guide; user's guide; instrument interface guide.

### ORDERING INFORMATION

**MI 5010** Multifunction Interface ..... **$1,725**

**MX 5010** Interface Extender ..... **$725**

**Utility Software**

For TM 5000/4041 Order 062-6958-01 ..... **$150**

For TM 5000/4052 Order 062-6957-01 ..... **$150**

Refer to page 323 for description and ordering information.

This utility software supports all of the 50MXX Series function cards also.

## 50M10

**Programmable A/D Converter**

**12-Bit Resolution**

**32 μs Conversion Time**

**Four Voltage Ranges ±100 mV to ±100 V**

**Data Transfer via GPIB or Front Panel Connector**

The 50M10 uses a 12-bit successive approximation conversion technique with a track-and-hold amplifier to achieve a total conversion time of 32 microseconds or less (approximately 30,000 conversions per second). Using the front panel connector, conversion values may be sent over the GPIB (via the MI 5010) or to external memory devices (such as the 50M50 Memory card). In either case, data is transferred in two eight-bit bytes. The lower six bits contain the converted value, high byte followed by low byte. The seventh bit is a high-low byte indicator. The eighth bit is unused.

Four voltage ranges are provided, manually selectable by on-board jumpers: +100 mV, +1 V, +10 V and +100 V. The total span for each range is divided into 4096 parts (12 bits). The front panel analog input connections (high and low) may be elevated to a potential of +340 volts, dc plus peak ac.

Two handshaking modes are provided, one for communication with devices faster than the 50M10 (the device can accept data as fast as the 50M10 can provide it), and the other for communication with devices slower than the 50M10 (the 50M10 must be clocked by the external receiving device). Front panel control lines permit the 50M10 conversions to be triggered, gated, or triggered within a gate. Through the use of a gateable function generator, such as the Tektronix FG 501A, and a digital delay generator, such as the Tektronix DD 501, a counted burst of conversions at a selected rate can be gated.

### CHARACTERISTICS

**Maximum Conversion Rate** — 32 μs.

**Maximum Aperture Time** — ≤400 ns.

**Accuracy**

| Range | +18°C to +28°C | 0°C to +50°C |
|---|---|---|
| 100 mV | ±0.15%*1 | ±0.25%*1 |
| 1 V and 10 V | ±0.075%*1 | ±0.125%*1 |
| 100 V | ±0.125%*1 | ±0.2%*1 |

*1 *Full scale.*

**Amplifier Settling Time** — 100 mV Range: ≤150 μs. 1 V Range: ≤25 μs. 10 V Range: ≤10 μs. 100 V Range: ≤30 μs.

**Input Impedance** — 100 mV, 1 V and 10 V Ranges: $\geq 10^{10}$ Ω. 100 V Range: ≥1 MΩ.

**Digital Data Transfer Format** — 12 bit word transferred in two bytes, high byte first. Lower six bits of each byte contain data, seventh bit is high byte/low byte indicator, eighth bit is unused.

**INCLUDED ACCESSORIES**

Instruction manual; reference guide.

### ORDERING INFORMATION

**50M10** Analog-to-Digital Converter Card ..... **$870**

## 50M20

### Programmable D/A Converter

- 12-Bit Resolution
- Voltage or Current Mode
- 20 μs (Maximum) Conversion Time
- 250 V RMS Isolation
- Mnemonic Instructions
- Self-Test and Error Indicators
- UL 1244 Listed

The 50M20 converts digital data to either analog voltage or current. The voltage or current mode is selectable manually via an on-board switch.

Data format is 12 bits, sent in two sequential 7-bit words. Data may be sent via the IEEE Standard 488 (GPIB) using the MI 5010 as the interface, or from an external (front connector) bus for high speed data transfer (with appropriate handshake lines). On-board firmware will convert commands and data to the proper format to perform the required digital-to-analog conversion. Two lines at the front panel connector are provided to handshake data into the 50M20 from the user's external system.

Programming of the 50M20 is via the IEEE Standard 488 (GPIB) Bus. System commands sent to the MI 5010 microprocessor, along with specialized programming commands unique to the 50M20, control the source and the format of the digital data. The 50M20 may be programmed to respond to either external or internal system triggers.

### CHARACTERISTICS

**VOLTAGE MODE**

**Range** — −10.240 V to +10.235 V.
**Accuracy** — ±10.0 mV (+20°C to +30°C) ±15 mV (0°C to +50°C).
**Resolution (1 LSB)** — 5 mV.
**Total Conversion Time (Maximum)** — 20 μs.
**Output Ripple and Noise** — <5 mV p-p at 5 MHz BW.
**Output Current Range** — 0 mA to ±5 mA.

**CURRENT MODE**

**Range** — −20.48 mA to +20.47 mA.
**Accuracy** — ±20 μA (+20°C to +30°C) ±40 μA (0°C to +50°C).
**Resolution (1 LSB)** — 10 μA.
**Total Conversion Time (Maximum)** — 20 μs.
**Output Ripple and Noise** — <15 μA, p-p, at 5 MHz BW.
**Compliance Voltage** — ±11 V.
**Isolation** — 250 V RMS maximum to ground.
**Digital Data Transfer Format** — 12 bit word transferred in two bytes, high byte first. Lower six bits of each byte contain data, seventh bit is high byte/low byte indicator, eighth bit is unused.

**INCLUDED ACCESSORIES**

Interfacing cable (015-0430-00); instruction manual; reference guide.

### ORDERING INFORMATION

**50M20** Digital-to-Analog Converter Card ..... **$890**

## 50M30

### Programmable Digital Input/Output Card

- 16 Digital Input and 16 Digital Output Lines
- Data Entry/Output Formats in Decimal, Binary, or Hex
- Triggered Externally or On Command
- Mnemonic Instructions
- Self-Test and Error Indicator
- UL 1244 Listed

The 50M30 provides 16 digital input and 16 digital output lines. The digital inputs accept data from pushbuttons, switches, contact closures, and most digital devices capable of supplying TTL output levels. The digital outputs provide TTL levels to control various types of test and measurement instruments, relays, indicators, etc. The digital outputs can be configured for open-collector outputs by positioning internal jumpers and using power supplied by the user.

Programming of the 50M30 is via the IEEE Standard 488 (GPIB) Bus. System commands sent to the MI 5010 Microprocessor, along with specialized programming commands unique to the 50M30, control the selection of the data input/output channels and the arming/trigger functions of the card.

Four lines at the front panel connector operate as input/output pairs to handshake data with the user's external system. One handshake pair allows the user's data source to be synchronized with the 50M30 data input register and the other handshake pair allows the user's data storage device to be synchronized with the 50M30 data output register.

### CHARACTERISTICS

**Data Outputs Using Internal Supply** — 16 open-collector TTL with 2 kΩ pullup resistors. Logical "1": +5 V ±2% (open circuit). Source current is −2.5 mA ±7% maximum. Logical "0": 0.2 V. Sink current is −40 mA maximum.

**Data Outputs Using External (User) Supply** — Maximum Voltage: +15 V. Pullup Resistors: 2 kΩ. Logical "1" equal to external supply voltage (open circuit). Source current is 7.5 mA ±5% plus external supply tolerance. Logical "0": 0.2 V. Sink current is 40 mA maximum.

**Data Inputs** — Input Buffers: 16 Schmitt triggers. Logical "1" (+V Threshold): +1.6 V ±25%. Source current is −0.14 mA nominal, −0.16 mA maximum. Logical "0" (−V Threshold): +0.8 V ±40%. Source current is −0.18 mA nominal, −0.21 mA maximum.

**INCLUDED ACCESSORIES**

Interfacing cable (015-0430-00); instruction manual; reference guide.

### ORDERING INFORMATION

**50M30** Digital Input/Output Card ..... **$480**

## 50M40

### Programmable Relay Scanner Card

- 16 Mercury Wetted Relay Contacts
- User Configurable
  - 1 — 1 of 16
  - 2 — 1 of 8
  - 4 — 1 or 4
- Triggered Externally or On Command
- Mnemonic Instructions
- Self-Test and Error Indicators
- UL 1244 Listed

The 50M40 provides 16 independent, normally-open relay contacts. The relay contacts may be used as switch closures to supply power to several external points from one source, or scan several sources and supply various inputs to a single measurement device.

The desired relay switch pattern is configured by the user with internal jumpers. When the configuration has been established, the relay scanning sequence, open and close operations, and triggering events are programmed over the IEEE Standard 488 GPIB Bus.

Two logic signal lines on the front panel connector are provided for externally controlling the 50M40—one as an output (Ready) to indicate to the user when the relays have settled, and the other as an input (Ext Trig) to tell the MI 5010 Microprocessor that the user is ready for the relay switch configuration to close. Three possible configurations are:

4 groups of 4 individual relays
2 groups of 8 individual relays
1 group of 16 individual relays

Scanning sequence and relay closure is accomplished under program control. Two logic signal lines on the front panel connector are provided for externally controlling the 50M40—one as an output (Ready) to indicate to the user when the relays have settled, and the other as an input (Ext Trig) to tell the MI 5010 Microprocessor that the user is ready for the relay switch configuration to close.

### CHARACTERISTICS

**Type of Relays** — Mercury wetted reed.

**Possible Configurations (Jumper Selectable)** — 1 of 4, 4 each. 1 of 8, 2 each. 1 of 16, 1 of 12 and 1 of 4, 1 each.

**Maximum Applied Voltage** — 40 V dc plus peak ac.

**Maximum Carry Current** — 1 A.

**Breakdown Voltage** — 100 V dc plus peak ac.

**Contact Resistance** — 0.15 Ω nominal (end of life).

**INCLUDED ACCESSORIES**

Interfacing cable (015-0430-00); instruction manual; reference guide.

### ORDERING INFORMATION

**50M40** Relay Scanner Card ..... **$675**

## 50M41

### Programmable Low-Level Scanner

**10 Differential Contact Pairs Plus Guard**

**<1 μV Low Thermal Offset**

**User Configurable**

**Handshake Lines to Permit External Control**

**Isothermal Amplifiers Available for Thermocouple Applications**

The 50M41 provides ten pairs of guarded, normally open relay contacts with less than one microvolt of thermal offset in each channel. Each differential pair of contacts is accompanied by a third contact to switch the shield or guard connection. The ten sets of relay contacts can be configured as two groups of five individual relays with two commons, or as one group of ten individual relays with one common. The desired relay switch pattern is configured by internal jumpers. A tree relay can be included in the 1-of-10 configuration to reduce capacitive loading and potential noise problems when using more than one 50M41 in a system. Two handshake lines are provided for externally controlling the 50M41.

A family of high-gain, low-noise signal conditioning modules—M41A1 through M41A8—is available to condition low-level signals for specialized applications with the 50M41. The M41A1 is a general purpose amplifier with switchable gain in decade steps from 1 to 1000. Provision is made for a guarded input that can be driven by the amplifier's guard driver or by an external signal source. A software selectable low-pass filter with a corner frequency of approximately 4 Hz provides more than 60 dB of normal mode rejection at 60 Hz. The frequency response with the filter turned off is approximately 10 kHz.

Signal conditioning modules M41A2 through M41A8 are thermocouple amplifiers, each designed to operate with a specific thermocouple type (J, K, E, T, S, R, and B, respectively). The thermocouple amplifier provides isothermal connections for up to ten guarded or unguarded thermocouple pairs. Each amplifier provides hardware compensation for its specific thermocouple type; provision for software compensation is made where all thermocouples are not of the same type. Thermocouples are available from your local supplier.

#### CHARACTERISTICS

**Type of Relays** — 10 sealed low-thermal-EMF relays configurable as one 10-to-1 switch or two 5-to-1 switches.
**Thermal Offset** — <1 μV differential; <2 μV differential with tree switch.
**Maximum Scan Rate** — ≥200 cycles/s.
**Maximum Applied Voltage (High, Low or Guard of Any Channel to Chassis)** — 350 V dc + peak ac.
**Maximum Switched Voltage** — 150 V dc + peak ac (not to exceed VA rating).
**Maximum Carry Current** — 250 mA.
**Maximum Switched Current** — 10 mA.
**Maximum Switched VA** — 0.15 VA.
**Included Accessories** — Instruction manual; reference guide.

#### ORDERING INFORMATION

**50M41** Low Level Scanner Card ..... **$995**

## 50M50

### Programmable Memory Card

**16 kbyte Digital Input/Output**

**Single 16-Bit or Dual 8-Bit Channels**

**Independent Dual-Channel Operation**

**200 kHz Acquisition or Generation Rate**

**TTL Levels**

The 50M50 is a 16 kbyte digital input/output device which can be configured, under program control, as a single 16-bit input/output port or as two 8-bit input/output ports. These ports can be connected to any of 16 data buffers which can be programmed to different lengths. The total memory of all the buffers cannot exceed 16 kbytes of storage.

The 50M50 is intended to be used as a digital word generator and/or as a fast, digital data acquisition buffer. As a digital word generator, the 50M50 can be used with a digital-to-analog converter, such as the Tektronix 50M20, to function as an arbitrary waveform generator. As a high speed data acquisition buffer, the 50M50 can be used with an analog-to-digital converter, such as the Tektronix 50M10, as an off-line, high-speed analog signal measurement system or as a waveform digitizer.

The 50M50 can be programmed to input or output data on two different channels simultaneously, or to input data on one channel while outputing data on the other channel. System commands to the 50M50 control the selection of input/output channels, the control of the data buffers, and the arming functions of the card.

Four handshake lines are provided at the front panel to permit synchronization with the user's external system (one pair for each channel). Other external control lines permit pacing and control of data output and disabling of data input.

#### CHARACTERISTICS

**Data Outputs** — 8 or 16 low-power Schottky TTL lines. Logical "1": +5 V ±2% (open circuit). Source current is 2.5 mA +2% −7% maximum. Logical "0": ≤0.7 V. Sink current is 40 mA maximum.

**Data Inputs** — 8 or 16 low-power Schottky TTL lines. Logical "1" (+V Threshold): +1.5 V to +2 V. Source current is −0.16 mA maximum. Logical "0" (−V Threshold): +0.6 V to +1.1 V. Source current is −0.21 mA maximum.

**Maximum Data Transfer Rate** — 8-Bit Bytes: 200 kHz ±2%. 16-Bit Bytes: 125 kHz ±2%.

#### INCLUDED ACCESSORIES

Instruction manual; reference guide.

#### ORDERING INFORMATION

**50M50** Memory Card ..... **$970**

## 50M70

### Programmable Development Card

**32 Data I/O Ports**

**Interrupt and Trigger Lines**

**Vector Board Development Region**

**Mnemonic Instructions**

**Self-Test and Error Indicator**

The 50M70 provides the user with the means of developing his own unique circuit and interfacing it to the GPIB without the need for designing and building the GPIB interface itself. With the 50M70, the user may create a specialized function card to be used in the MI 5010/MX5010 Multifunction Interface System. When completed, the circuit can be programmed in high level language over the GPIB.

The 50M70 contains two 68B21 16-bit interface logic registers (PIAs), address and data buffers, its own firmware, and a 4x4-inch breadboard area for circuit development. The 32 data lines of the PIAs can be individually programmed as inputs or outputs. The PIAs also provide three sets of programmable two-wire handshake lines to permit triggering of the external system by the 50M70 or of the 50M70 by the external system.

Typical 50M70 applications are specialized A/D and D/A converter functions, counter/timer applications, special communication interface functions, keyboard and display functions, digital comparators for triggering and interrupt functions, etc.

#### CHARACTERISTICS

**Data Input/Outputs and Handshake Lines** — Output High Level: +2.4 V minimum, +5.5 V maximum. Maximum Load Current: −200 μA. Output Low Level: 0 V minimum, +0.4 V maximum. Maximum Sink Current: 3.2 mA. Input Load Current: 1.3 mA nominal, 2.4 mA maximum.
**Dc Voltage Sources Available on the Card** — +26 V and −26 V ±9%, 100 mA maximum; +8 V ±5%, 600 mA maximum; +5 V ±5%, 1.5 A maximum. Total Combined Power Limit: 7.5 W.

#### INCLUDED ACCESSORIES

Interfacing cable (015-0430-00); instruction manual, reference guide.

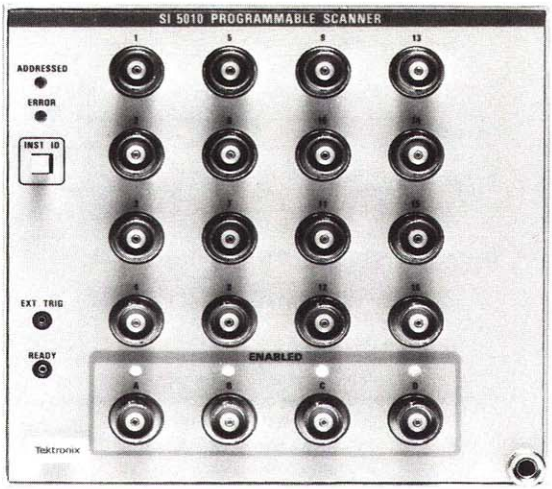
#### ORDERING INFORMATION

**50M70** Development Card ..... **$395**

#### MULTIFUNCTION INTERFACE SYSTEM OPTIONAL ACCESSORIES

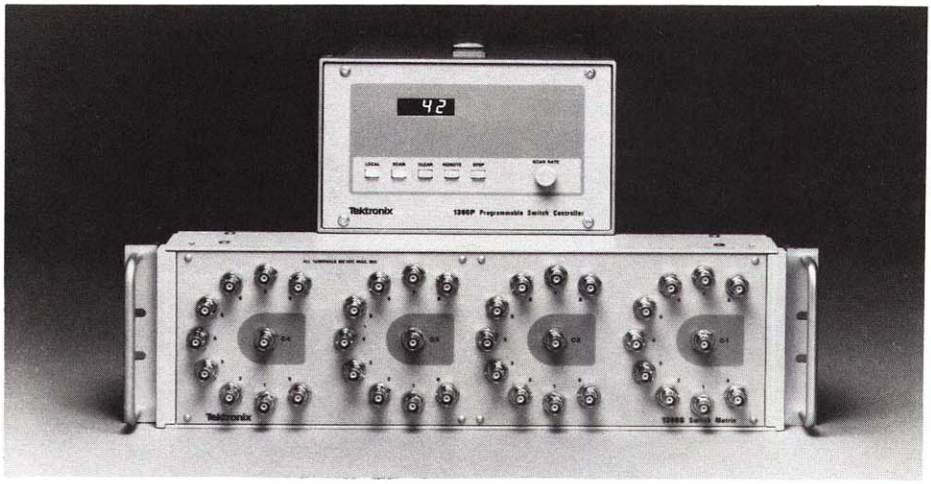
**Interfacing Cable** — 50-conductor flat ribbon cable with connector to mate with front panel connector of any Multifunction Interface System function card. Other end of the 48-inch cable terminates in bare tinned leads. (This cable is a standard accessory with 50M20, 50M30, 50M40, and 50M70 cards.) Order 015-0430-00 ..... **$65**
**Single-Width Interfacing Adaptor** — Mates with any single Multifunction Interface System function card to permit customized interface wiring between cards or to external system under test. Will accommodate up to five screw terminal blocks (131-3083-00 below). Order 015-0466-00 ..... **$125**
**Screw Terminal Block** — Mounts in 015-0466-00 Interfacing adaptor above to permit wiring changes without soldering (ten terminals per block). Order 131-3083-00 ..... **$9.25**
**Function Card Access Shield** — Dummy function card of insulating material to protect against possible electrical shock or damage in partially filled MI 5010 or MX 5010. Order 020-0836-00 ..... **$19**
**Multifunction Interface System Card Extender** — Permits operation of a function card while extended from the front of an MI 5010 or MX 5010. Order 067-1066-00 ..... **$150**
**Triple-Width Interfacing Adaptor** — Mates with up to three Multifunction Interface System function cards in an MI 5010 or MX 5010 to permit interface wiring among cards or to external system under test. Contains two 131-3083-00 screw terminal blocks. Order 015-0473-00 ..... **$200**

**SI 5010**




**Programmable Scanner**

**1360P/1360S**




**Programmable Signal Multiplexer**

## GPIB IEEE-488 SI 5010

The SI 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**Software Configurable as:**
- **1 Group of 16 Channels**
- **2 Groups of 8 Channels**
- **4 Groups of 4 Channels**

**350 MHz Bandwidth in 4-Channel Configuration**

**External Handshake Lines**

**Built-In Time-of-Day and Pacing Clock**

**Command Buffer for Controller-Free Operation**

The SI 5010 Programmable Scanner provides the capability of switching and routing up to 16 high frequency input and/or output signals. It always maintains a clean 50-ohm environment through the use of 50-ohm coaxial reed relays. The software-configurable basic four-channel arrangement allows the SI 5010 to be used for point-to-point switching (any connector to any other connector), or to be used in a wide variety of fan-in and/or fan-out configurations.

The SI 5010 has its own intelligence and a built-in command buffer capable of storing up to 300 system commands and executing them in sequence. It is paced by the on-board time-of-day and pacing clock or by signals from the system under test. This requires no interference from the system controller, thus freeing the controller to direct activity elsewhere in the system.

Two handshake lines are provided for externally controlling the SI 5010. An Ext Trig line is provided to allow the SI 5010 switching to be initiated by the external system under test, and a Ready line indicates to the external system when the relays have settled.

### CHARACTERISTICS

**RF Connectors** — Twenty BNC connectors, 16 channels and four commons.
**Control Input (Ext Trig)** — External Trigger: TTL compatible
**Control Output Data Accepted (Ready)** — TTL compatible. Output goes high when relays have settled.
**Channel Configuration (Software Selectable)** — 1, 2, 3, or 4 groups of 4 channels. 2 groups of 8 channels. 1 group of 16 channels.
**Frequency Response** — Any 1 Group of 4: −3 dB at 350 MHz, decreasing to −6 dB at 500 MHz or greater. Any 1 Group of 8: −3 dB at 175 MHz or greater. Any 1 Group of 16: −3 dB at 80 MHz or greater.
**Port (Channel) Isolation** — 40 dB at 100 MHz.
**Characteristic Impedance (Each Channel)** — 50 Ω. See vswr specification.
**Risetime (Each Channel)** — <1 ns.
**Voltage Standing Wave Ratio (Vswr)** — Any 4 Channel Group: 1.25:1 at 100 MHz, increasing to 1.8:1 at 350 MHz. Any Other Combination: 1.5:1 at 100 MHz. 2:1 at 225 MHz.
**Insertion Loss** — <1 dB at 100 MHz.
**Channel Delay Matching** — Any Group of 4: 50 ps. Any Group of 8: 110 ps. Any Group of 16: 310 ps.
**Type of Relays** — 16 Form A, EAC 05Y21A1 40 BAB, or equivalent. 4 Form "C", TO-5, Teledyne 712-6, or equivalent. Pull In Time: 3 ms. Release Time: 3 ms. Breakdown Voltage: 350 V (dc + peak ac). Series Path Resistance (End of Life): 0.5 Ω.
**Peak Carry Voltage** — Unterminated: 40 V maximum. 50 Ω Terminated: 12.5 V maximum.
**Peak Contact Current** — 0.25 A maximum.
**Peak Switching Voltages** — Unterminated: 15 V maximum. 50 Ω Terminated: 3.73 V maximum.
**Peak Switching Current** — 0.01 A maximum.
**Included Accessories** — Instruction manual, reference guide.

### ORDERING INFORMATION

**SI 5010** Scanner ..... **$2,225**
**Utility Software**
For TM 5000/4041 Order 062-6958-01 ..... **$150**
For TM 5000/4052A Order 062-6957-01 ..... **$150**
Refer to page 323 for description and ordering information.

## GPIB IEEE-488 1360P/1360S

The 1360P/1360S comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**Signal Bandwidth to 300 MHz**

**50 Ω Environment**

**Selected Pole Readout**

**Flexible Switch Configuration**

**Rackmount or Benchtop**

The 1360P/1360S Programmable Signal Multiplexer is a microprocessor-based, GPIB-compatible system instrument which is used to multiplex electrical signals. The 1360P/1360S system includes two separate chassis: the 1360P Programmable Switch Controller and the 1360S Switch Matrix. The 1360P/1360S is not part of the TM 5000 Family and thus does not require a TM 5000 mainframe for operation.

The 1360P Programmable Switch Controller is controlled via the GPIB and provides all the signals required for control of up to four 1360S Switch units. The 1360P is housed in an 8.5 inch wide (half-rackwidth) rackmount chassis, with right or left slider assemblies for rackmounting.

The 1360S Switch Matrix contains four 9-to-1 switches which can be cascaded to provide two 17-to-1 switches; a 25-to-1 switch and a 9-to-1 switch; or a 33-to-1 switch. Up to four 1360S Switch units can be controlled by one 1360P Controller unit to provide up to 129-to-1 multiplexing. In the 9-to-1 configuration, the 1360S has a signal bandwidth of 250 MHz; make/break time in all configurations is <1 ms. The switches in the 1360S can also be ganged together to provide simultaneous and synchronized multiplexing of several groups of signals.

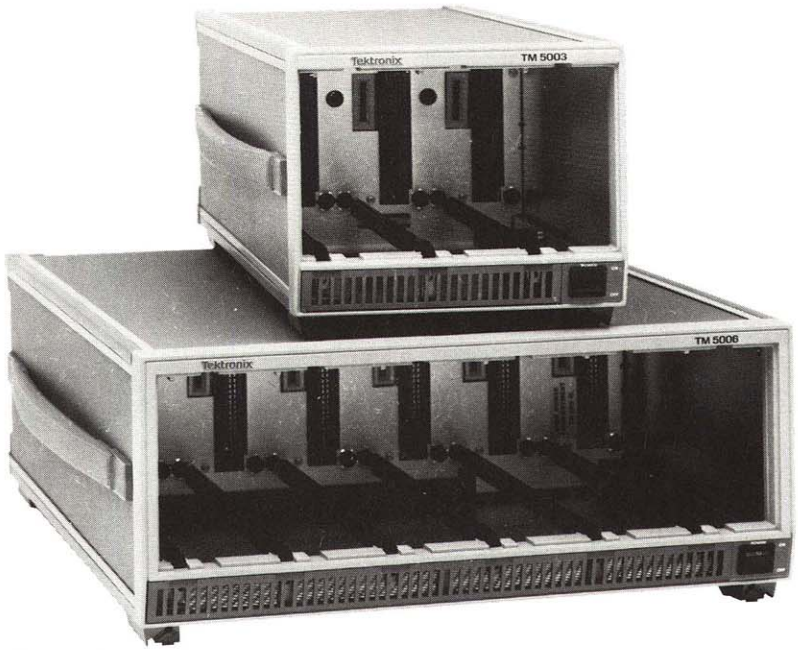
The 1360S is housed in a 5.75-inch high, 19-inch wide rackmount chassis 3-inches deep.

### CHARACTERISTICS

**Bandwidth (3 dB—Through One Switch Only)** — Dc to 300 MHz.
**Maximum Input Voltage** — 250 V dc + peak ac (not to exceed 10 VA).
**Maximum Carry Current** — 250 mA (not to exceed 10 VA).
**Vswr (Through One Switch Only)** — 5.0 at 450 MHz; 3.9 at 400 MHz; 1.9 at 250 MHz; 1.2 at 100 MHz.
**Characteristic Impedance** — 50 Ω ±1 Ω.
**Scan Rate Variability** — >10 s to <3 ms.
**Make/Break Time** — ≤1 ms.
**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**1360P** Switch Controller ..... **$2,640**
**1360S** Switch Matrix ..... **$1,610**




*TM 5003 and TM 5006 mainframes shown above.*

## GPIB IEEE-488 TM 5003/TM 5006

The TM 5003 and TM 5006 comply with IEEE Standard 488-1978

The TM 5000 mainframes extend the convenience of the TM 500 concept into the programmable instrument/IEEE Standard 488 area. The TM 5003 accepts up to three instruments at one time; the TM 5006 accepts up to six instruments at one time. These two TM 5000 mainframes were designed specifically for use with the Tektronix TM 5000 line of programmable, IEEE Standard 488 compatible test and measurement instruments, but all of the TM 500 manual plug-in instruments will also operate in these same mainframes allowing manual and programmable instruments to be mounted together in adjacent slots. This capability permits unique compact combinations of test instruments to be assembled for specific test applications.

Any of the mainframes may be operated with less than a full complement of plug-in instruments installed. TM 5000 instruments cannot be operated in TM 500 mainframes.

### Benchtop or Portability

The two benchtop mainframes are the TM 5003 and the TM 5006. The TM 5003 is the most compact, accommodating three single-wide plug-ins. The TM 5006 includes a high-power compartment at the right-hand end to supply higher current levels to instruments that provide higher performance or higher output levels. Both the TM 5003 and TM 5006 incorporate a quiet fan for optimum cooling; have feet, tilt-bails, handles, and front-panel power switches. Both operate from 110 V ac or 220 V ac.

All benchtop models have carry handles for portable applications.

### Rackmount

The TM 5006 Option 10 is electrically identical to the standard TM 5006 and features a slide assembly and handles, plus a higher-power fan than the bench version to accommodate the higher ambient temperatures often found in enclosed racks and consoles. Kits are available to rackmount a TM 5003 with a 4041 System Controller.

### Rear Interface Capability

Using Option 02 for either mainframe gives the same rear interfacing capability as described for the TM 500 Series mainframes. Refer to page 398.

### Economy

TM 5000 mainframes represent a most economical approach in test and measurement instrumentation. Relatively fixed packaging costs for frames, covers, primary power circuits, unregulated secondary power circuits, and other items are a significant portion of the cost of a typical instrument. Since these fixed costs associated with packaging are shared by many functional instruments in the TM 5000 line, the cost-per-function may be lower than comparable, one or two-function monolithic instruments. Because of its modularity, expandability, and versatility, the modular concept represented by TM 5000 may provide the lowest cost-per-test/measurement when you are considering multifunction usage.

Reduced cabling costs made possible by the rear-interface capability, the requirement for fewer GPIB cables for an equal number of instruments in the TM 5000 line; and the reduced space requirements for a measurement system all contribute to unprecedented economy for test and measurement requirements.

## CHARACTERISTICS

### POWER REQUIREMENTS

All of the mainframes have manually selectable taps on the power transformer which permit operation on 100 V, 110 V, 120 V, 200 V, 220 V, or 240 V ±10%.

**Power Line Frequency Range** — 48 Hz to 66 Hz.

**Maximum Power Consumption** — Shown in Mainframes Dimensions and Weights chart.

## MAINFRAMES DIMENSIONS AND WEIGHTS (WITHOUT PLUG-INS)

| | TM 5003 | | TM 5006 | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 230 | 9.0 | 445 | 17.5 |
| Height | 194 | 7.6 | 194 | 7.6 |
| Depth | 488 | 19.2 | 488 | 19.2 |
| **Weight ≈** | **kg** | **lb** | **kg** | **lb** |
| Net | 8.6 | 19.0 | 14.5 | 32.0 |
| Shipping | 12.0 | 26.5 | 20.9 | 46.0 |
| Max Power Consumption*1 | 300 VA | | 650 VA | |

**1 Actual power consumption depends on plug-in selection and operating modes.*

### ENVIRONMENTAL CHARACTERISTICS

**Temperature Range** — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Altitude Range** — Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea Level to 15 000 m (50,000 ft).

## ORDERING INFORMATION

**TM 5003** Power Module Mainframe ..... **$820**
**Option 02** — Rear Interface ..... **+$100**

**TM 5006** Power Module Mainframe ... **$1,090**
**Option 02** — Rear Interface ..... **+$190**
**Option 10** — Rackmount ..... **+$100**
**Option 12** — Option 02 and Option 10 Combined ..... **+$290**

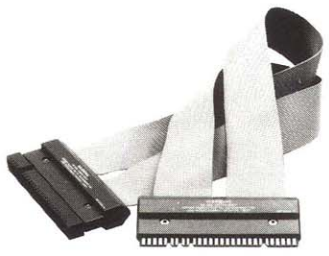
### CONVERSION KITS

**Cabinet-to-Rackmount Conversion Kit** — Equipped with slide out assembly, required to convert a TM 5006 to rackmount capability. Order 040-0982-01 ..... **$160**

**Rackmount-to-Cabinet Conversion Kit** — Equipped to convert a TM 5006 with rackmount capability to cabinet style. Order 040-0983-00 ..... **$75**

**Cabinet-to-Rackmount Conversion Kit** — Equipped with slide-out assembly to rackmount a 4041 Instrument Controller to the left of a TM 5003. Order 040-0984-00 ..... **$190**

### FLEXIBLE PLUG-IN EXTENDER CABLE



Designed to couple a TM 500 or TM 5000 Plug-in with the mainframe rear interface board connection extender, cables provide a completely flexible connecting point outside the mainframe for plug-in operation during test or check-out.

**GPIB Extender Cable** for TM 5000 mainframes. Order 067-0996-00 ..... **$110**

**Extender Cable** for TM 500 mainframes. Order 067-0645-02 ..... **$145**

### TM 500/TM 5000 INSTRUMENTATION SYSTEM ACCESSORIES GPIB INTERCONNECTING CABLES

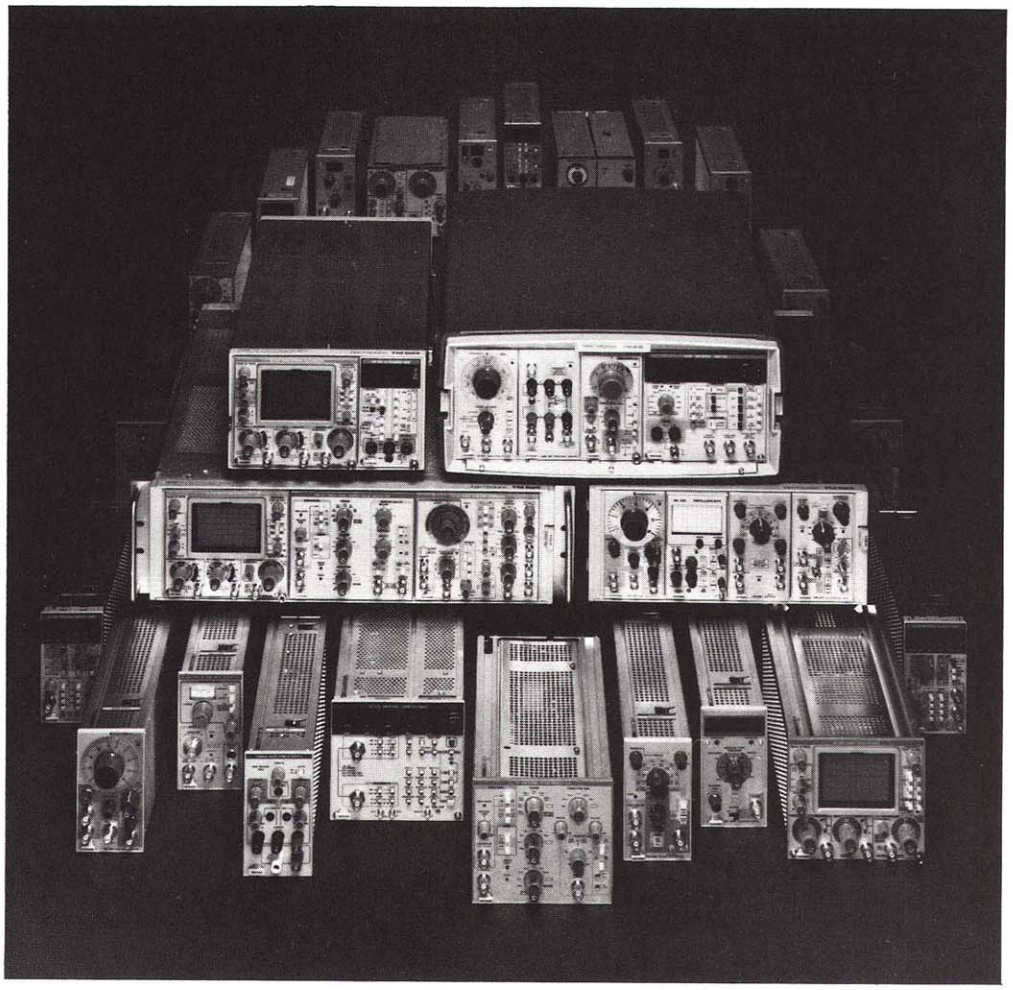
**GPIB Cable** — 0.5 m. Order 012-1015-00 ..... **$65**
**GPIB Cable** — 2 m. Order 012-0630-01 ..... **$75**
**GPIB Cable** — 2 m, Double Shielded. Order 012-0630-03 ..... **$90**
**GPIB Cable** — 4 m, Double Shielded. Order 012-0630-04 ..... **$150**

### RS-232C INTERCONNECTING CABLES

**Male Connector** — Pins on one end, female on the other. Order 012-0911-00 ..... **$85**
**Male Connector Pins on Both Ends** — 16 ft. Order 012-0716-00 ..... **$90**
**Male Connector Pins on Both Ends** — 50 ft. Order 012-0717-00 ..... **$185**
**SCSI (ANSI X3T9.2/82.2)** — 2 m Standard Cable, 4041 Option 03 to Disk Storage Unit. Order 012-0037-00 ..... **$205**

**For additional accessories, see page 399-401.**

# TM 500 MODULAR TEST AND MEASUREMENT INSTRUMENTS



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**Manual Instruments that Perform in Hundreds of Combinations**
Configurability is the watchword for TM 500 instruments and mainframes. You can create multifunction packages that encompass a wide diversity of applications. Or solve one unique application problem.

You choose from almost forty ready-to-go, compact plug-ins for a range of test and measurement needs. TM 500 Instruments include digital counters, pulse generators, function generators, amplifiers, signal processors, audio oscillators, a distortion analyzer, ramp generators, calibration instruments, power supplies, oscilloscopes, digital delay, and a digital latch. Plus three different blank plug-in kits for customizing special functions.

You put your instruments together in the mainframe that best suits your environment. There's a travel mainframe for service work and field testing; a rackmount model for production and test; or standard mainframes, compact and convenient for bench or desk, that accept one to six instruments. Rollabout carts are available for lab configurations with Tek oscilloscopes.

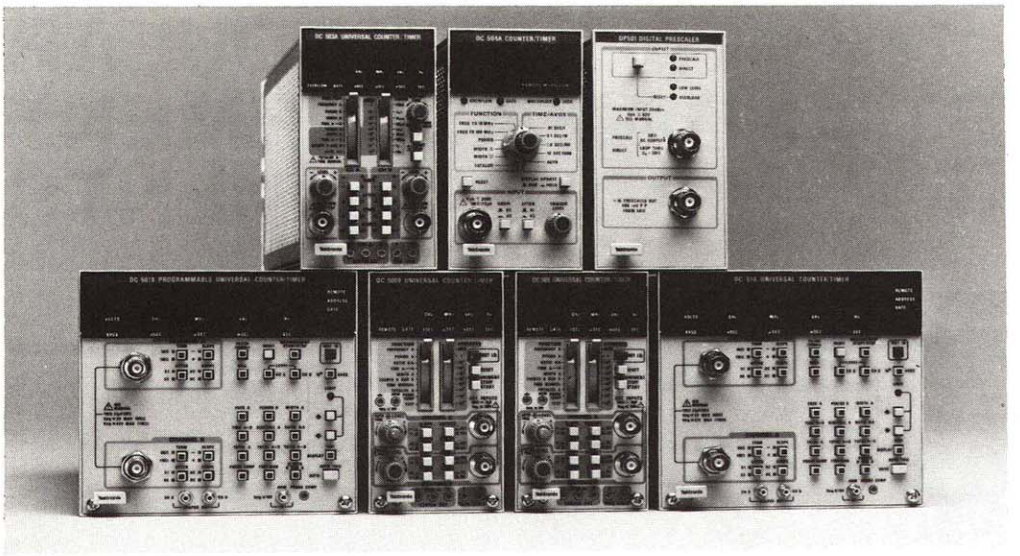
All TM 500 instruments and mainframes are electrically and mechanically compatible. So, through interfacing, you can configure an instrument system more powerful than the sum of its parts: an audio lab with distortion analyzer and storage scope, for example.

All of the TM 500 manual instruments may be used in TM 5000 mainframes side-by-side with the TM 5000 GPIB programmable instruments for cost effective solutions to system application where not all functions or measurements need to be programmed.

Cost efficiency is as important a part of the TM 500 concept as solving applications problems. You add on performance capabilities when you need them. And when you do add them, you can still use the same mainframe and power supply you started with.

**Application and Construction Notes**
The TM 500 instrument line is supported by an on-going program to keep you informed of how to achieve optimal performance and versatility from your TM 500 instruments. Tektronix' goal of providing you with solutions to difficult measurement problems does not end with your purchase of TM 500 instruments.
Application Notes take you through the steps necessary to solve complex problems, or to make more useful measurements with your TM 500 instruments. Subjects include integration through v to f conversion, generating delayed pulses, and current sinking with power supply modules.

Construction Notes provide information necessary to build custom circuits using a blank plug-in kit and standard components. These notes are developed from the actual construction of more common special circuits and include parts lists, schematics and other construction details. Some of the available TM 500 blank plug-in construction notes include: power supply circuits, thermal true RMS converter, and analog multipliers.



**A Counter for Every Purpose**
The TM 500 Family of digital counters provides a selection of four counters, each with its own performance and price niche, plus a prescaler which adds 1.3 GHz frequency measurement capability to the line.

The 350 MHz DC 510 and the 135 MHz DC 509 Universal Counter/Timers feature reciprocal frequency measurements and an especially wide range of other measurement functions; plus autotrigger, autoaveraging, arming, probe compensation, and more. And IEEE Standard 488 compatibility can be added as a field modification.

The DC 503A 125 MHz Universal Counter/Timer offers a wide choice of performance features, including period, width, and time-interval averaging.

The easy-to-use 100 MHz DC 504A features autorange, period and width averaging, and a 100X resolution multiplier to provide high resolution of low frequency signals.

The DP 501 Digital Prescaler adds 1.3 GHz frequency counting capability to all of the above counters except the DC 504A.

**Microprocessor-Based High Performance**
Both the DC 510 and DC 509 are microprocessor-based, and contain features available only in high performance, microprocessor-based instruments. Both use a powerful dual-register architecture to obtain high-resolution counting of low frequency signals. The DC 510 provides nine digits of resolution in about a third of a second; the DC 509 provides eight digits of resolution in about a second. The DC 510 provides 3.125 ns single-shot resolution for time-interval measurements. The DC 509 provides 10 ns resolution. With averaging the DC 510 can provide 1 ps resolution on time-interval measurements (the best available today); the DC 509, 5 ps resolution.

Other features available in both instruments include autotrigger, autoaveraging, probe compensation, and diagnostic self-test. At the push of a button, the autotrigger feature senses the top and bottom of the applied signal and automatically sets the trigger point midway between the two.

Autoaveraging provides the optimum combination of resolution and measurement time, regardless of the frequency of the signal. Both autotrigger and autoaveraging can be overridden to allow manual (or programmable, in the case of the GPIB versions) control of averaging, measurement time, and triggering levels.

The probe compensation feature on both instruments allows the user to quickly and accurately compensate a high-impedance probe to the instrument input impedance directly. Improperly compensated probes are a common source of timing errors when using counters without this feature.

Both instruments include an arming input and shaped outputs for added versatility when measuring selected parts of complex waveforms.

Both feature a phase-modulated time base to eliminate clock synchronous errors in all time averaging modes.

In addition to all the features of the DC 509, the DC 510 permits direct measurement and display of risetime and falltime.

The addition of the GPIB interface board (a field modification) converts both the DC 510 and DC 509 into their fully programmable, fully GPIB-compatible versions, the DC 5010 and DC 5009, respectively. See pages 355-358 for more information on these and other fully-programmable, GPIB-compatible products in the Tektronix TM 5000 product line.

**Versatility in Counting, the DC 503A**
The DC 503A features eight measurement functions, including period, width, and time-interval averaging. Both input channels have the full 0 MHz to 125 MHz frequency range, 20 mV RMS sensitivity, and separate controls for input coupling, attenuation, trigger level, and trigger slope. The 10 MHz clock provides 100 ns resolution of single-shot time-interval measurements, and 10 ps resolution with averaging.

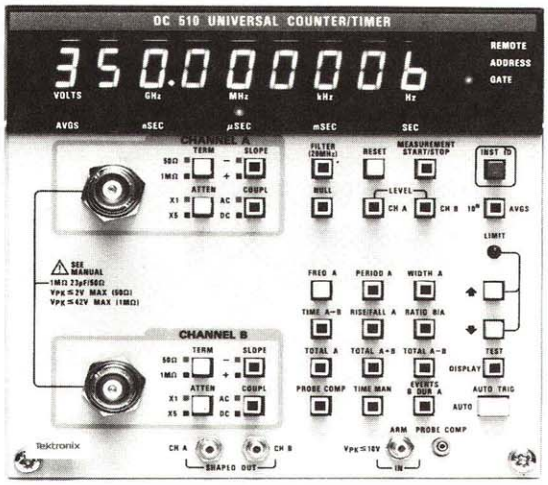
An optional accessory probe, the Tektronix P6125, has been especially designed for use with digital counters. The 5X attenuation provides an optimum match between the counter input characteristics and the voltage levels of all common logic families. Low input capacitance permits acquisition of high-frequency signals with minimum loading of the circuits under test.

**DIGITAL COUNTERS—SELECTION GUIDE**

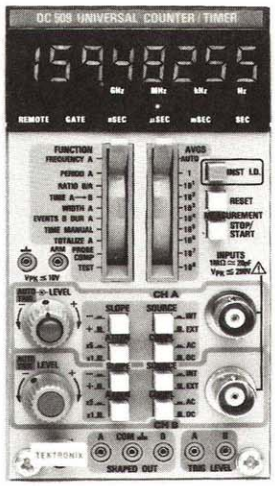
| | DC 510/DC 5010 | DC 509/DC 5009 | DC 503A | DC 504A |
|---|---|---|---|---|
| Frequency Range | 350 MHz | 135 MHz | 125 MHz | 100 MHz |
| Number of Digits | 9 | 8 | 8 | 6 |
| Ratio Architecture | Yes | Yes | No | No |
| Period Averaging | Yes | Yes | Yes | Yes |
| Width Averaging (Single Input) | Yes | Yes | Yes | Yes |
| Time Interval Averaging | Yes | Yes | Yes | No |
| Autotrigger | Yes | Yes | No | No |
| Gated Events Averaging | B during A | B during A | A during B | No |
| Ratio Averaging | Yes | Yes | Yes | No |
| Other | Option 01, C shaped outputs self-test, phase modulated clock probe compensation 1 ps resolution 50 Ω/1 MΩ, (time A-B average) IEEE Standard 488 fully programmable (DC 5010) | Option 01, trigger level and shaped outputs, self-test, phase modulated clock, probe compensation IEEE Standard 488 fully programmable (DC 5009) | Option 01, trigger level and shaped outputs, time manual, totalize | Autorange, 100X resolution multiplier |
| Mainframe Compatibility | DC 510 TM 500/TM 5000 DC 5010 TM 5000 only | DC 509 TM 500/TM 5000 DC 5009 TM 5000 only | TM 500 TM 5000 | TM 500 TM 5000 |

For compatible accessories — refer to page 417.

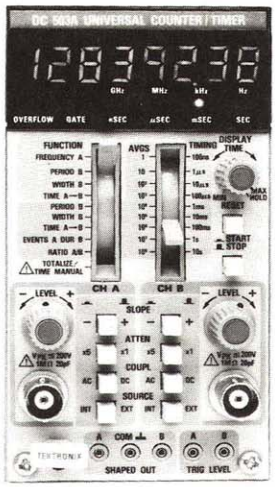
DC 510




DC 509




DC 503A




**Universal Counter/Timers**

## DC 510/DC 509

- 350 MHz Both A and B Channels (DC 510)
- 135 MHz Both A and B Channels (DC 509)
- 3.125 ns Single-Shot Resolution (DC 510)
- 10 ns Single-Shot Resolution (DC 509)
- 9-Digit Display (DC 510)
- 8-Digit Display (DC 509)
- 1 ps Resolution, with Averaging (DC 510)
- 5 ps Resolution, with Averaging (DC 509)

With the exception of programmability and IEEE Standard 488 compatibility, the characteristics and specifications of the DC 510/DC 509 Universal Counter/Timers are identical to those of the DC 5010/DC 5009 Universal Counter/Timers. The detailed specifications of the DC 5010/DC 5009 Universal Counter/Timers are given on pages 355-358.

A conversion kit is available to owners of DC 510's and DC 509's who desire IEEE Standard 488 capabilities. The field modification kit easily converts a DC 510 to a DC 5010 or a DC 509 to a DC 5009.

### ORDERING INFORMATION

**DC 510** Universal Counter/Timer ..... **$3,750**

**DC 509** Universal Counter/Timer ..... **$2,040**

#### OPTIONAL ACCESSORIES

**Option 01** — High Stability Time Base ..... **+$325**

**Field Option 01 Kit** — For DC 510/5010 or DC 509/5009. Order 040-0966-00 ..... **$250**

**Field GPIB Kits** — For DC 510. Order 040-1023-04. For DC 509. Order 040-0957-04 ..... **$290**

#### RECOMMENDED PROBE

**P6125 5X** — Passive Probe. Order 010-6125-01 ..... **$70**

## DC 503A

- 125 MHz Both A and B Channels
- Eight Measurement Functions:
  - Frequency
  - Period and Period Average
  - Width and Width Average
  - Time A→B and Time A→B Average
  - Events A During B and Events A During B Average
  - Totalize
  - Time Manual
  - Ratio A/B Average
- 10 ps Resolution in Time Interval Average with $10^8$ Averages
- Shaped Outputs for Ease of Triggering
- 40 MHz Rep Rate in Time Interval Average
- Simplified Width Measurement
- Designed for True Probe Compatibility
- Trigger Level Outputs for Accurate Trigger Setting

The DC 503A offers a broad range of measurement features at an affordable price. The instrument has two input channels, A and B, each with 125 MHz capability. Each channel has separate triggering level, triggering slope, attenuator, and coupling mode controls. Eight measurement functions are available with the DC 503A and an averaging feature allows averaging of 1 to $10^8$ occurrences of the signal of interest. Signals to be counted or timed can be applied to channels A and B via front panel BNC connectors, or through rear interface connections. The DC 503A features an easy access front panel and an LSI based design for increased instrument reliability.

The DC 503A can be equipped with an optional temperature controlled 10 MHz crystal oscillator (Option 01) to obtain a highly stable and precise internal time base. Both the optional oscillator and the standard 10 MHz crystal oscillator provide 100 ns resolution of single-shot time intervals.

### CHARACTERISTICS

**Display** — Eight digit LED; indicators for units, gate open, and overflow.

**Display Time** — ≈0.2 s to 5 s and hold.

#### CHANNEL A AND B INPUT

**Frequency Range** — 0 MHz to 125 MHz, dc coupled. 10 Hz to 125 MHz, ac coupled.

**Sensitivity** — 20 mV RMS sinewave to 100 MHz, 35 mV RMS sinewave to 125 MHz. 60 mV p-p; at minimum pulse width of 5 ns to 100 MHz. 100 mV p-p at minimum pulse width of 4 ns to 125 MHz.

**Impedance** — 1 MΩ paralleled by ≈27 pF.

**Attenuation** — Selectable 1X, 5X.

**Dynamic Range** — V p-p ≤3 V x attenuation. V peak ≤3.5 x attenuation.

**Trigger Level** — Adjustable ±3.5 V x attenuation.

**Independent Controls** — Slope +/−, Attenuation 1X/5X, Coupled ac/dc, Source Internal/External.

**Maximum Input Voltage**
1X: 200 V peak; 400 V p-p from dc to 50 kHz, derate to 15 V p-p from 1.33 MHz to 125 MHz.
5X: 200 V peak; 400 V p-p from dc to 5 MHz, derate to 20 V p-p from 100 MHz to 125 MHz.

**Shaped Out** — Shaped replica of signal being measured, aids proper triggering on complex waveforms. ≥200 mV p-p from 50 Ω.

**Trigger Level** — A dc level corresponding to the actual trigger level. Accuracy ±20 mV ±0.5% of reading.

#### FREQUENCY A

**Range** — 0 MHz to 125 MHz.

**Resolution** — 0.1 Hz to 10 MHz in decade steps.

**Accuracy** — ±1 count ± time base error x Frequency A.

#### PERIOD B (SINGLE SHOT)

**Range** — 100 ns to $10^9$ s.

**Resolution** — 100 ns to 10 s in decade steps.

**Accuracy** — ±1 count ± time base error x Period B ±1.4 x CH B trigger jitter error.

**Frequency Range** — 0 MHz to 125 MHz.

#### PERIOD B (Average)

**Range** — 8 ns to 10 s.

**Resolution** — 1 fs ($10^{-15}$) to 100 ns in decade steps.

**Events Averaged (N)** — 1 to $10^8$.

**Accuracy** — $\pm\frac{100\text{ ns}}{N}$ ± time base error x Period B

$\pm\frac{1.4 \times \text{CH B trigger jitter error}}{N}$

**Frequency Range** — 0 MHz to 125 MHz.

#### WIDTH B (SINGLE SHOT)

**Range** — 100 ns to $10^9$ s.

**Resolution** — 100 ns to 10 s in decade steps.

**Accuracy** —
±1 count ± time base error x Width B.
±CH B start trigger jitter error
±CH B stop trigger jitter error
+(CH B stop slew rate error—CH B start slew rate error).

**WIDTH B (AVERAGE)**

**Range** — 5 ns to 10 s.

**Resolution** — $\frac{100\text{ ns}}{\sqrt{N}}$

**Events Averaged (N)** — 1 to $10^8$ in decade steps.

**Accuracy** —

$\pm\frac{100\text{ ns}}{\sqrt{N}}$ ± time base error x width B.

$\pm\frac{\text{CH B start trigger jitter error}}{\sqrt{N}}$

$\pm\frac{\text{CH B stop trigger jitter error}}{\sqrt{N}}$

+(CH B stop slew rate error −CH B start slew rate error)

**Frequency Range** — 0 MHz to 100 MHz.

**TIME A → B (SINGLE SHOT)**

**Range** — 100 ns to $10^9$ s.

**Resolution** — 100 ns to 10 s in decade steps.

**Accuracy** —

± 1 count ± time base error x Time A → B

± CH A trigger jitter error

± CH B trigger jitter error

±(CH B stop trigger slew error

− CH A start trigger slew error) ± 4 ns.

**TIME A → B (AVERAGE)**

**Range** — 12.5 ns to 10 s.

**Resolution** — $\frac{100\text{ ns}}{\sqrt{N}}$

**Minimum Dead Time** — 12.5 ns (Stop-to-Start).

**Events Averaged (N)** — 1 to $10^8$ in decade steps.

**Accuracy** —

$\pm\frac{100\text{ ns}}{\sqrt{N}}$ ± time base error x Time A → B

$\pm\frac{\text{CH A trigger jitter error}}{\sqrt{N}}$

$\pm\frac{\text{CH B trigger jitter error}}{\sqrt{N}}$

+(CH B stop trigger slew error

− CH A start trigger slew error) ± 4 ns

**EVENTS A DURING B (AVERAGE)**

**Maximum A Frequency** — 125 MHz.

**Minimum B Pulse Width** — 5 ns.

**Events Averaged (N)** — 1 to $10^8$ in decade steps.

**Accuracy** —

$\pm\frac{\text{Period A}}{\text{Width B} \times \sqrt{N}}$ x Events A during B

$\pm\frac{\text{CH B start trigger jitter error}}{\sqrt{N}}$ x Frequency A (in MHz)

$\pm\frac{\text{CH B stop trigger jitter error}}{\sqrt{N}}$ x Frequency A (in MHz)

+(CH B stop trigger slew error

− CH B start trigger slew error) x Frequency A (in MHz)

**RATIO A/B**

Averaged over 1 to $10^8$ cycles of CH B signal.

**Frequency Range** — 0 to 125 MHz (both CH A and CH B).

**Accuracy** — $\pm\frac{\text{Frequency B}}{\text{Frequency A} \times N}$

$\pm\frac{1.4 \times \text{CH B trigger jitter error} \times \text{Frequency A}}{N}$

$\pm\frac{\text{Frequency A}}{0.3 \times 10^8}$

**TOTALIZE A**

1 count to 99,999,999 counts at maximum rate of 125 MHz. Start, stop and reset controlled by front panel pushbuttons or rear interface signal lines.

**TIME MANUAL**

Electronic stopwatch, accumulates and displays time between activation of front panel start/stop button or rear interface signal line. Clock rates selectable from 100 ns to 10 s in decade steps. Range 100 ns to $10^9$ s.

**STANDARD TIME BASE**

**Crystal Frequency** — 10 MHz.

**Temp Stability** — < ±5 x $10^{-6}$, 0°C to +50°C.

**Aging Rate** — <1 x $10^{-6}$ per year.

**Setability** — Adjustable to within 5 x $10^{-8}$.

**OPTION 01 HIGH STABILITY TIME BASE**

**Crystal Frequency** — 10 MHz.

**Temp Stability** — < ±2 x $10^{-7}$ after warm-up, 0°C to +50°C.

**Warmup Time** — Within 2 x $10^{-7}$ of final frequency in <10 minutes when cold started at 25°C.

**Aging Rate** — 1 x $10^{-8}$/day at time of shipment, 4 x $10^{-8}$/week after 30 days of continuous operation, 1 x $10^{-6}$/year after 60 days of continuous operation.

**Setability** — Adjustable to within 2 x $10^{-8}$.

**REAR INTERFACE**

**Inputs** — Direct count input to 50 MHz, (50 Ω impedance, resistor may be removed for 1 MΩ impedance, remote start/stop, reset; external time base.

**Outputs** — BCD serial-by-digit, decimal point, overflow, scan clock; trigger level; time base reference.

**THE SOLUTION AND ACCURACY DEFINITIONS**

Time base error is the sum of all errors specified for the time base used.

N is the number of periods averaged in Period B (AVGS) mode, the number of intervals averaged in the Time A → B (AVGS) mode, the number of widths of B averaged in Width B (AVGS) and Events A During B modes, and the number of periods of B in the Ratio A/B mode.

**Trigger jitter error (in μs)** = $\frac{\sqrt{(en_1)^2 + (en_2)^2\text{ (V)}}}{\text{Input slew rate at trigger point (V/μs)}}$

Where: $en_1$ = 100 μV RMS typical internal noise.

$en_2$ = RMS noise of signal input at trigger point for a 125 MHz bandwidth.

**Trigger slew rate error (in μs)** = $\frac{\text{Input hysterisis (V)/2}}{\text{Input slew rate at set trigger point V/μs}}$

Where: Input hysterisis = 20 mV peak-to-peak typical.

**Included Accessories** — Service manual; operator's manual.

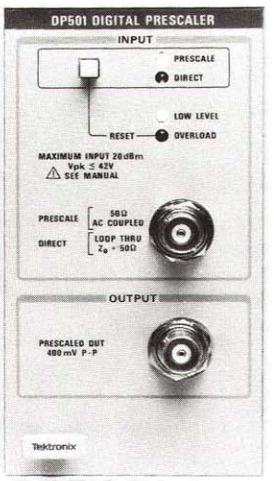
## ORDERING INFORMATION

**DC 503A** Universal Counter/Timer ..... **$1,165**

**Option 01** — High Stability Time Base ..... +$325

**Field Option Kit** — Order 040-0966-00 ..... **$250**

### DP 501




**Digital Prescaler**

# DP 501

**Extends Frequency Measurement Capability to 1.3 GHz**

**Compatible with Most TM 500 and TM 5000 Counters**

**AGC**

**Low Level Indicator**

The DP 501 Digital Prescaler adds 1.3 GHz frequency counting capability to the Tektronix DC 503A, DC 509, DC 5009, DC 510, and DC 5010 Universal Counter/Timers.

In use, the DP 501 is placed in the signal line between the signal source and the counter's input connector such that the signal to be measured passes through the DP 501. Two operating modes are available, Prescale and Direct. In the Prescale mode, the DP 501 divides the input signal by 16 and causes the associated counter's display to be multiplied by 16, so that the counter will display the correct frequency. In the Direct mode, the signal is simply looped through the DP 501 and applied directly to the counter's input; the counter's display is not affected. This loop-through capability eliminates the need for external switching when input signal frequencies occur in both the Prescale and Direct frequency ranges.

The prescaling function can be activated in either of two ways: manually, with a front-panel push button; or, when used with the GPIB programmable DC 5009 or DC 5010, by a Prescale command to the counter. Thus, the DP 501 adds programmable frequency measurements to 1.3 GHz to the Tektronix TM 5000 Family of GPIB programmable instruments.

Input sensitivity in the Prescale mode is 20 mV RMS to 1 GHz and 30 mV RMS to 1.3 GHz. A Low-Level indicator alerts the user if the input signal amplitude is too low for error-free counting. An automatic gain control circuit provides optimum immunity to signal noise in the Prescale mode.

The DP 501 and DC 509 or DC 510 can be used with the Tektronix 7L14 Spectrum Analyzer and TR 502 Tracking Generator to provide counter accuracy measurements of swept-frequency signals from 100 kHz to 1.3 GHz.

## CHARACTERISTICS

**Prescale Mode**

Input: Frequency range is ≤100 MHz to ≥1.3 GHz.
Sensitivity: 100 MHz to 1 GHz is ≤20 mV RMS (−21 dBm).
1 GHz to 1.3 GHz is ≤30 mV RMS (−17 dBm).
Impedance: 50 Ω, ac coupled; vswr ≤2.2:1.
Output: Amplitude into 50 Ω is ≥200 mV, p-p. Unterminated is 2X terminated value.

**Direct Mode**

Input: Connected directly to output.
Frequency Range: 0 MHz to >350 MHz.
Impedance: Loop through characteristic impedance is 50 Ω; nonterminated capacitance ≈20 pF (no connection to output).
Output: Connected directly to input. <1 dB insertion loss up to 350 MHz. Powers up in direct mode.

**Overload Protection**

Prescale: Input disconnects when input signal exceeds +20 dBm ±5 dBm for a period of ≈0.5 s or more.

**Damage Level**

Prescale: Input may be damaged if signal level exceeds +25 dBm.
Direct: 42 V peak maximum. Maximum current is 250 mA.

**Input Attenuation**

Automatic: Up to 40 dB range.

**Low Level Indicator** — Lights when input signal is below that required for error-free counting.

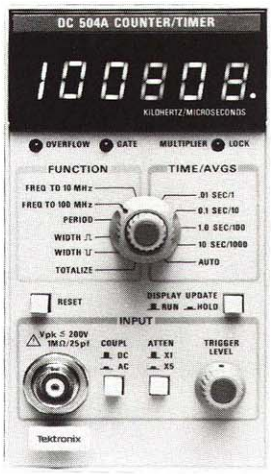
**Tracking Generator Compatibility** — Outputs will drive two standard TTL loads. Inputs represent two standard TTL loads. Requires arming input to associated counter.

**Included Accessory** — Instruction manual.

## ORDERING INFORMATION

**DP 501** Digital Prescaler ..... **$525**

**DC 504A**




**Counter/Timer**

# DC 504A

## Dc to 100 MHz

## Period and Period Averaging

## Width and Width Averaging

## Autoranging

## 100X Resolution Multiplier

The easy-to-use DC 504A Counter/Timer measures frequency from dc to 100 MHz, with an internal prescaler being used for frequencies above 10 MHz. Both direct and prescaled counting are done through the same input connector; no need to change connectors when changing frequency range. Autoranging permits virtual hands-off operation for most measurements. The 100X resolution multiplier automatically provides 0.01 Hz resolution in one second—or 0.001 Hz resolution in ten seconds—on signals from 10 Hz to 25 kHz.

The DC 504A features period and width averaging of up to 1000 events. Selectable dc coupling of the input eliminates the potential errors associated with making width measurements on signals of varying duty cycle with counters that are only ac coupled. Input trigger sensitivity is 30 mV RMS across the entire 100 MHz frequency range. The triggering level range of ±2 volts and the selectable 5X attenuator provides a triggering range of up to ±10 volts.

The totalize mode permits totalizing up to 999,999 events—and beyond, with overflow—with a Display Update-Run/Hold control to hold the display while the internal counter continues to advance.

## CHARACTERISTICS

**Display** — Six-digit LED readout with automatic decimal point positioning and leading zero suppression. LED annunciators indicate gate open, resolution multiplier lock, and display overflow.

### INPUT CHARACTERISTICS

**Input Frequency Range**
Front Panel: Dc Coupled: 1 MHz to 100 MHz. Ac Coupled: 10 Hz to 100 MHz.
Rear Interface: Dc Coupled: 0 MHz to 50 MHz. Ac Coupled: 10 Hz to 50 MHz.

**Input Sensitivity**
1X Attenuation: 30 mV RMS sinewave (85 mV p-p) to 100 MHz; 85 mV p-p pulse at a minimum width of 5 ns.
5X Attenuation Accuracy: Within 2% at dc.

**Input Dynamic Range**
1X: ±2.0 V peak, 4 V p-p.
5X: ±10 V peak, 20 V p-p.

**Trigger Level Range** — ±2.0 V x attenuation, minimum.

**Maximum Safe Input Voltage**
Front Panel:
1X: 200 V peak; 400 V p-p from dc to 50 kHz, derate to 15 V p-p from 1.33 MHz to 100 MHz.
5X: 200 V peak; 400 V p-p from dc to 50 MHz, derate to 20 V p-p at 100 MHz.
Rear Interface: ≤4 V peak.

**Input Impedance**
Front Panel: 1X, 5X: 1 MΩ, paralleled by ≈25 pF.
Rear Interface: 1X, 5X: 50 Ω ±10% at dc.

### FREQUENCY TO 10 MHz

**Range** — Dc Coupled: 0 Hz to 10 MHz. Ac Coupled: 10 Hz to 10 MHz.

**Accuracy** — ±1 count ±time base error x frequency.

**Gate Time** — 10 ms to 10 s, selectable in decade steps; or autoranging (10 ms to 1 s only).

**Resolution**
Multiplier Off: 100 Hz to 0.1 Hz, selectable in decade steps; or autoranging (100 Hz to 1 Hz only).
Multiplier On: 1 Hz to 0.001 Hz, selectable in decade steps; or autoranging (1 Hz to 0.01 Hz only).
Lock Range: 10 Hz ≤Frequency ≤25 kHz.
Multiplication: 100X.
Lock Time: ≤5 s.
Resolution multiplier automatically increases resolution by 100 when locked; may be defeated by an internal jumper.

### FREQUENCY TO 100 MHz

**Range** — Dc Coupled: 0 Hz to 100 MHz. Ac Coupled: 10 Hz to 100 MHz.

**Prescale Factor** — ÷10.

**Accuracy** — ±1 count ±time base error x frequency.

**Gate Time (Resolution)** — 10 ms to 10 s (1 kHz to 1 Hz), selectable in decade steps; or autoranging (10 ms to 1 s only).

### PERIOD AVG

**Frequency Range** — Dc Coupled: 0 Hz to 2.5 MHz. Ac Coupled: 10 Hz to 2.5 MHz.

**Events Averaged (N)** — $10^0$ to $10^3$, selectable in decade steps; or autoranging ($10^0$ to $10^2$ only).

**Resolution** — 100 ns to 100 ps, selectable in decade steps; or autoranging (100 ns to 1 ns only).

**Accuracy** —

$$\pm\frac{100\text{ ns}}{N} \pm \text{ time base error x period.}$$

$$\pm 1.4 \times \left(\frac{\text{trigger jitter error}}{N}\right)$$

### WIDTH AVG

**Frequency Range** — Dc Coupled: 0 Hz to 2.5 MHz. Ac Coupled: 10 Hz to 2.5 MHz.

**Events Averaged (N)** — $10^0$ to $10^3$, selectable in decade steps; or autoranging ($10^0$ to $10^2$ only).

**Resolution** — $\pm\frac{100\text{ ns}}{\sqrt{N}}$

**Accuracy** —

$$\pm\frac{100\text{ ns}}{\sqrt{N}} \pm \text{ time base error x width.}$$

$$\pm\frac{\text{start trigger jitter error}}{\sqrt{N}}$$

$$\pm\frac{\text{stop trigger jitter error}}{\sqrt{N}}$$

+(stop slew rate error - start slew rate error)

±10 ns

### TOTALIZE

**Frequency Range** — Dc Coupled: 0 Hz to 10 MHz. Ac Coupled: 10 Hz to 10 MHz. Overflows above 999,999. Display update Run/Hold will hold display while counter continues to advance. Releasing Run/Hold will update display to new value.

### RESOLUTION AND ACCURACY DEFINITIONS

Same as DC 503A except DC 504A has 100 MHz bandwidth and input hysteresis = 30 mV p-p typical.

### TIME BASE

**Time Base**
Frequency (At Calibration): 10 MHz ±1 x $10^{-7}$.
Adjustment Resolution: ±5 x $10^{-8}$.
Temperature Stability (0°C to +50°C): ±5 x $10^{-6}$ (±5 ppm).
Aging: ≤1 x $10^{-6}$/year (≤1 ppm/year).
**External Time Base Input** — 10 MHz.
Must drive 1 LSTTL load.
$V_{IH}$ = 2.0 V/20 μA
$V_{IL}$ = 0.8 V/−400 μA
**Included Accessory** — Instruction manual.

## ORDERING INFORMATION

**DC 504A** Counter/Timer ..... **$780**

### OPTIONAL COUNTER ACCESSORIES

**P6101 X1 Probe** — Dc to 34 MHz. Order 010-6101-03 .. **$67**
**P6106 X10 Probe** — Dc to 300 MHz. Order 010-6106-03 ..... **$140**
**P6201 FET Probe** — Dc to 900 MHz. Order 010-6201-01 ..... **$1,210**
**P6230 Bias/Offset Probe** — Dc to 1.5 GHz. Order 010-6230-01 ..... **$395**
**P6056 50 Ω, X10 Probe** — Dc to 3.5 GHz. Order 010-6056-03 ..... **$185**
**Power Divider** — GR, 50 Ω. Order 017-0082-00 ..... **$375**
**Adaptor** — GR to BNC female. Order 017-0067-00 ..... **$55**
**Adaptor** — GR to BNC male. Order 017-0064-00 ..... **$75**
**Cable Adaptor** — BNC to tipjack (DC 503A, DC 509,DC 5009). Order 175-3765-01 ..... **$28**
**Cable Adapator** — BNC to RF (DC 510, DC 5010). Order 012-0532-00 ..... **$35**

# P6125 Counter Probe

The P6125 is a low-capacitance, 5X attenuation passive probe specially designed for use with counter/timers. It makes possible more accurate time interval measurements of high speed logic signals. Five-times attenuation provides an optimum match between the counter input characteristics and the voltage levels of all common logic families. The low input capacitance permits acquisition of high frequency signals with minimum loading of the circuits under test.

## CHARACTERISTICS

**Attenuation** — 5X.
**Input Resistance** — 5 MΩ input.
**Capacitance** — ≈20 pF.
**Bandwidth** — Dc to 200 MHz.
**Voltage Rating** — 250 V (dc + peak ac) derated to 35 V at 100 MHz.
**Cable Length** — 1.5 meters.

### INCLUDED ACCESSORIES

8 cm ground lead (175-0263-01); two miniature alligator clips (344-0046-00); accessory pouch (016-0521-00); IC tip tester*1, two 13 cm ground lead probe*2 tips (175-0124-01); retractable hook tip (013-0107-03); probe holder (352-0351-00); insulating sleeve (166-0404-01); instruction manual.

**1 Available in pkgs of 10 (015-0201-04) or 100 (015-0201-05).*
**2 Available in pkgs of 10 only (206-0191-03).*

## ORDERING INFORMATION

**P6125** Counter Probe, 5X, 1.5 m. Order 010-6125-01 ..... **$70**

When your test and measurement problems require more waveforms for more applications, the high performance TM 500 Function Generators are a versatile solution singly or in combination with one another.

For applications demanding logarithmic or linear sweep the FG 507 offers an accurate and versatile solution. The low distortion, combined with log and linear sweep, is particularly useful in audio and linear communications-oriented applications.

For low-frequency function generator applications, set the FG 501A, FG 502, FG 503, or FG 507 to work on biological, geophysical and mechanical simulations or on servo systems.

Applying an external ramp to the VCF input allows any of the TM 500 function generators to double as sweep generators. Applying a suitable modulating signal can produce a frequency-modulated carrier. In addition, the FG 504 and FG 507 can supply internally generated linear or logarithmic sweeps with convenient two-dial control of start and stop frequencies.

Sweeping wide frequency ranges (up to 1000:1) with logarithmic sweep allows you to spread out lower octaves, sweep a full range in less time, and produce easy-to-read Bode plots and graphs.

You can control the starting phase of a waveform in the gated burst or triggered mode with the FG 501A, FG 504, FG 507 and the FG 5010. A gated or triggered waveform efficiently tests tone-controlled systems, loud speaker transient response characteristics, automatic gain control circuits, or other amplitude sensitive systems.

The FG 504's phase lock mode feature lets you convert digital signals to high or low voltage sinewaves, pulses, or triangles; ideal for locking the function generator's output to a house or system frequency standard. With the DD 501 Digital Delay Generator in the "divide by n" mode, the FG 504 can be locked to your frequency reference at a lower frequency.

## FUNCTION GENERATORS

| | FG 501A | FG 507 |
|---|---|---|
| **Waveforms** | Sine, Square, Triangle, Pulse and Ramp with variable symmetry | |
| **Symmetry** | ≤5% to ≥95% Variable | ≤5% to >95% Variable |
| **Frequency Range** | 0.002 Hz to 2 MHz<br>200 kHz ±10% with variable symmetry on | 0.002 Hz to 2 MHz<br>200 kHz ±10% with variable symmetry on |
| **Dial Accuracy (% of Full Scale) (except FG 5010)** | Within 3% | Within 3%<br>Within 5% in sweep mode*2 |
| **Custom Frequency Range** | No | No |
| **Frequency Stability (% of Full Scale)** | ≤0.05% for 10 min., ≤0.1% for 1 hour, ≤0.5% for 24 hours, constant temperature | |
| **Amplitude: Open Circuit** | 30 V p-p | 30 V p-p |
| **Into 50 Ω** | 15 V p-p | 15 V p-p |
| **Attenuator** | 0 to −60 dB in 20 dB Steps<br>>20 dB additional with AMPL control | |
| **Offset: Open Circuit** | ±13 V dc, step attenuator decreases offset | |
| **Into 50 Ω** | ±6.5 V dc, step attenuator decreases offset | |
| **Pk Sig + Offset: Open Circuit** | ±15 V | ±15 V |
| **Into 50 Ω** | ±7.5 V | ±7.5 V |
| **Output Impedance** | 50 Ω | 50 Ω |
| **Amplitude Flatness (10 kHz ref, 50 Ω load) Sine-wave** | ±0.1 dB 20 Hz to 20 kHz<br>±0.5 dB 20 kHz to 1 MHz<br>±1 dB 1 MHz to 2 MHz | ±0.1 dB 20 Hz to 20 kHz<br>±0.5 dB 20 kHz to 1 MHz<br>±1 dB 1 MHz to 2 MHz |
| **Triangle** | ±0.5 dB 20 Hz to 200 kHz<br>±2 dB 200 kHz to 2 MHz | ±0.5 dB 20 Hz to 200 kHz<br>±2 dB 200 kHz to 2 MHz |
| **Square-wave** | ±0.5 dB 20 Hz to 2 MHz | ±0.5 dB 20 Hz to 2 MHz |
| **Sinewave Distortion (Maximum Output, 50 Ω load)** | ≤0.25% 20 Hz to 20 kHz*2<br>≤0.5% 20 kHz to 100 kHz<br>Harmonics:<br>≤−30dB, 100 kHz to 2 MHz | ≤0.25% 20 Hz to 20 kHz*2<br>≤0.5% 20 kHz to 100 kHz<br>Harmonics:<br>≤−30 dB, 100 kHz to 2 MHz |
| **Squarewave Response** | ≤25 ns rise/fall<br><3% p-p aberrations | ≤25 ns rise/fall<br><3% p-p aberrations |
| **Triangle Linearity (10% to 90%)** | ≥99% 20 Hz to 200 kHz<br>≥97% 200 kHz to 2 MHz | ≥99% 20 Hz to 200 kHz<br>≥97% 200 kHz to 2 MHz |
| **Trigger Output** | ≥+4 V from 50 Ω | ≥+4 V from 50 Ω |
| **External Input** | Impedance ≈2 kΩ<br>Trigger threshold level +1 V ±20% | Impedance ≈2 kΩ<br>Trigger threshold level +1 V ±20% |
| **Trigger** | ±90° variable start phase control | ±90° variable start phase control |
| **Gate** | ±90° variable start phase control | ±90° variable start phase control |
| **Phase Lock** | No | No |
| **Counted Burst** | With DD 501 | With DD 501 |
| **Internal Sweep** | No | Logarithmic or Linear, Separate Start/Stop Dials |
| **Duration** | NA | 1 ms to 100 s |
| **External Trigger** | | ±1 V ±20 % trigger level<br>≈2 kΩ input impedance |
| **Ramp Output** | | ≤0.3 V to 10 V from 1 kΩ ±5% |
| **Gate Output** | | ≥+4 V from 50 Ω |
| **Other Modes** | | Manual Sweep Trig<br>Manual Sweep<br>Sweep and Hold |
| **Amplitude Modulation** | No | No |
| **Voltage Controlled Frequency (FM)** | Up to 1000; 1 Frequency change with 10 V external signal<br>Slew rate ≥0.3 V/μs, 10 kΩ input impedance | |
| **Nominal Hz/Volt Sensitivity** | 2 x Frequency Multiplier setting | 2 x Frequency Multiplier |
| **Output Hold Mode** | No | No |
| **Temperature*4** | 0°C +50°C Operating, −55°C to +75°C Nonoperating | |

*1 +15° C to +35° C ambient
*2 +20° C to +30° C ambient
*3 20 Hz to 20 kHz modulation frequency
*4 FG 504 requires forced air circulation above +40° C.
*5 Fully programmable, see page 360 for complete information.
*6 IEEE Standard 488 Compatible
*7 Percent of indicated frequency
*8 Absolute voltage accuracy
*9 Separate FM function provided (1%/V)

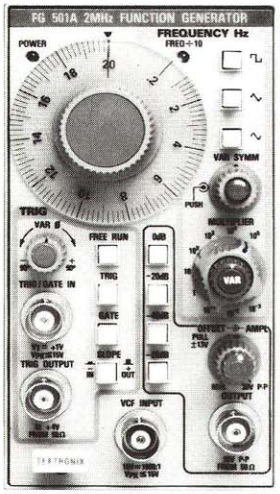
Compatible accessories begin on page 458.

## COMPARISON OF CHARACTERISTICS

| | FG 504 | FG 502 | FG 503 | FG 5010*5*6 |
|---|---|---|---|---|
| **Waveforms** | Sine, Square, Triangle, Pulse and Ramp with variable symmetry | Sine, Square, Triangle Pulse, or Ramp | Sine, Square, Triangle | Sine, Square, Triangle, Pulse and Ramp with variable symmetry |
| **Symmetry** | 7% to 93% Variable | 5%, 50%, 95% Fixed | 50% Fixed | 10% to 90%, 1% steps |
| **Frequency Range** | 0.001 Hz to 40 MHz<br>4 MHz nominal with variable symmetry on | 0.1 Hz to 11 MHz<br>Pulse and Ramp, 1.1 MHz | 1.0 Hz to 3 MHz<br>Usable 0.01 Hz to 5 MHz | 0.002 Hz to 20 MHz |
| **Dial Accuracy (% of Full Scale) (except FG 5010)** | Within 3% to 4 MHz*1<br>Within 6% to 40 MHz*1 | Within 3% to 1 MHz<br>Within 5% to 10 MHz | Within 5% | Within 0.1% of selected frequency<br>Digital LED Display |
| **Custom Frequency Range** | Shipped with capacitor for 20 Hz to 20 kHz | No | With user-installed capacitor | NA |
| **Frequency Stability (% of Full Scale)** | ≤0.05% for 10 minutes, ≤0.1% for 1 hour, ≤0.5% for 24 hours, constant temperature | | | ≤0.05% for 1 hr, 0.05% for 24 hrs (≤0.1% in trigger, gate, burst mode <200 Hz)*7 |
| **Amplitude: Open Circuit** | 30 V p-p | 10 V p-p | 20 V p-p | 20 V p-p |
| **Into 50 Ω** | 15 V p-p | 5 V p-p | 10 V p-p | 10 V p-p |
| **Attenuator** | 0 to −50 dB in 10 dB steps<br><10 mV p-p with VAR control | Variable control only | Variable control only | Digital Control of fixed and variable<br>10 mV p-p into 50 Ω |
| **Offset: Open Circuit** | ±7.5 V dc | ±5 V dc | ±7.5 V dc | ±7.5 V dc |
| **Into 50 Ω** | ±3.75 V dc | ±2.5 V dc | ±3.75 V dc | ±3.75 V dc |
| **Pk Sig + Offset: Open Circuit** | ±20 V | ±10 V | ±15 V | ±15 V |
| **Into 50 Ω** | ±11.25 V | ±5 V | ±6 V | ±7.5 V |
| **Output Impedance** | 50 Ω | 50 Ω | 50 Ω | 50 Ω |
| **Amplitude Flatness (10 kHz ref, 50 Ω load) Sine-wave** | ±0.5 dB 0.001 Hz to 40 kHz | ±0.5 dB 20 Hz to 20 kHz<br>±1.5 dB 0.1 Hz to 11 MHz | ±0.5 dB 20 Hz to 20 kHz<br>±2 dB 0.1 Hz to 3 MHz | ±3% from 0.002 Hz to 1 kHz<br>±3.5% from 1 kHz to 1 MHz<br>±5% from 1 MHz to 5 MHz<br>+5%, −10% from 5 MHz to20 MHz |
| **Triangle** | ±2 dB 40 kHz to 40 MHz | ±3 dB referenced to Sinewave | ±1 dB referenced to Sinewave | ±2% from 0.002 Hz to 1 kHz<br>±3.5% from 1 kHz to 100 kHz<br>±4% from 100 kHz to 1 MHz<br>+4%, −5% from 1 MHz to 5 MHz<br>+4%, −20% from 5 MHz to 20 MHz |
| **Square-wave** | ±0.5 dB to 20 MHz<br>±2 dB to 40 MHz | | | ±2% from 0.002 Hz to 1 kHz<br>±3.5% from 1 kHz to 1 MHz<br>±5% from 1 MHz to 10 MHz<br>±10% from 10 MHz to 20 MHz |
| **Sinewave Distortion (Maximum output, 50 Ω load)** | ≤0.5% 20 Hz to 40 kHz*1<br>Harmonics:<br>≤−30 dB 40 kHz to 1 MHz<br><−20 dB 1 MHz to 40 MHz | ≤0.5% 10 Hz to 50 kHz*2<br>Harmonics:<br>≤−30 dB at all other frequencies | ≤0.5% 1 Hz to 30 kHz<br>≤1.0% 30 kHz to 300 kHz<br>≤2.5% 300 kHz to 3 MHz | ≤0.5% 20 Hz to 19.99 kHz*1<br>≤1.0% 20 kHz to 99.99 kHz<br>Harmonics >30 dB down, 100 kHz to 20 MHz |
| **Squarewave Response** | ≤6 ns rise/fall fixed 10 ns to 100 ms variable<br>≤5% p-p +30 mV aberrations | ≤20 ns rise/fall<br>≤3% p-p aberrations | ≤60 ns rise/fall<br>≤3 p-p aberrations | ≤10 ns rise/fall<br>≤5% p-p aberrations |
| **Triangle Linearity (10% to 90%)** | ≥99% 10 Hz to 400 kHz<br>≥95% 400 kHz to 40 MHz<br>type ≥98% 0.001 Hz to 10 Hz | ≥99% 0.1 Hz to 100 kHz<br>≥97% 100 kHz to 1 MHz<br>≥95% 1 MHz to 11 MHz | ≥99% 1 Hz to 100 kHz<br>≥95% 100 kHz to 3 MHz | >98% to 2 MHz<br>>90% to 20 MHz |
| **Trigger Output** | ≥+2 V from 50 Ω | +2.5 V to 50 Ω load | +2.5 V to 600 Ω load | +2 V from 50 Ω |
| **External Input** | Impedance ≥10 kΩ<br>Sensitivity ≤1 V p-p<br>Trigger level −1 V to +10 V | Impedance ≈1 kΩ<br>≥+2 V Gate Signal required | No | 1 MΩ/50 Ω internal setability<br>0.0 V/0.5 V internal setability |
| **Trigger** | 20 MHz maximum<br>±80° start phase control to 10 MHz | No | No | ±90° variable start phase control |
| **Gate** | | Fixed 0° start phase | No | ±90° variable start phase control |
| **Phase Lock** | 100 Hz to 40 MHz<br>±80° phase range | No | No | 20 Hz to 20 MHz<br>(Auto Scan) |
| **Counted Burst** | With DD 501 | With DD 501 | No | 1 to 9999 |
| **Internal Sweep** | Logarithmic or Linear, Separate Start/Stop Dials | No | No | No |
| **Duration** | 0.1 ms to 100 s | NA | NA | NA |
| **External Trigger** | +1 V to +10 V trigger level<br>1 V p-p sensitivity | | | |
| **Ramp Output** | 0 to +10 V from 1 kΩ<br>±5% to 1 ms, ±10%<br>≤1 ms | | | |
| **Gate Output** | No | | | |
| **Other Modes** | Manual Sweep Trig | | | |
| **Amplitude Modulation** | 100% with nominal 5 V p-p input<br>Dc to 100 kHz modulation frequency<br><5% distortion to 4 MHz at 70%*3<br><10% distortion to 40 MHz at 65%*3 | No | No | 100% with nominal 5 V p-p input<br>Dc to 100 kHz modulation frequency<br><2% distortion to 2 MHz at 70%<br><4% distortion to 20 MHz at 70% |
| **Voltage Controlled Frequency (FM)** | Up to 1000: 1 Frequency change with 10 V external signal<br>Slew rate ≥0.3 V/ms, 10 kΩ input impedance | | | Up to 1000: 1 frequency*9<br>change with 10 V external input |
| **Nominal Hz/Volt Sensitivity** | 4 x Frequency Multiplier | 1.1 x Frequency Multiplier | 3 x Frequency Multiplier | 10% of selected range |
| **Output Hold Mode** | 0.001 Hz to 400 Hz | No | No | 0.002 Hz to 200 Hz |
| **Temperature*4** | 0°C to +50°C Operating, −55°C to +75°C Nonoperating | | | |

Compatible accessories begin on page 458.

**FG 501A**




2 MHz Function Generator

## FG 501A

**0.002 Hz to 2 MHz**

**30 V Peak-to-Peak, ±13 V Offset**

**5% to 95% Variable Symmetry**

**Trigger or Gate, ± Slope**

**60 dB Step Attenuator**

**I0.25% Sinewave Distortion**

**I25 ns Rise/Fall**

The FG 501A provides low-distortion outputs from 0.002 Hz to 2 MHz. It is capable of generating five basic waveforms—sinewave, squarewave, triangle, ramp, and pulse—at output levels up to 30 V peak-to-peak with up to ±13 V of offset from a 50 Ω source. Waveform triggering and gating are provided with a variable phase control to permit up to ±90° of phase shift for generating haversines, $\sin^2$ pulses, and haver triangles. A step attenuator provides 60 dB of output signal attenuation in 20 dB steps with an additional 20 dB of variable attenuation. Variable symmetry from 5% to 95% provides ramps and pulses. Pulse risetime is ≤25 ns. Audio sinewave distortion is ≤0.25% and audio amplitude flatness is within 0.1 dB.

Because of its ability to generate low distortion sinewaves, the FG 501A is uniquely appropriate for applications demanding audio signals.

Also useful in audio applications is the 0 dB to 60 dB attenuator designed into the FG 501A.

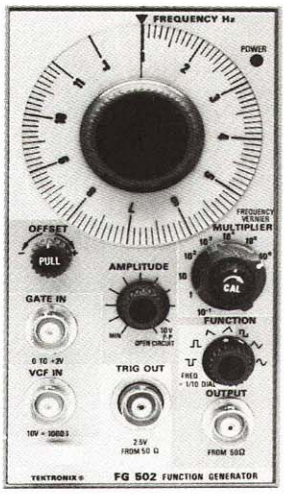
The wide range variable symmetry of the FG 501A is useful for generation of pulses and ramps.

**Included Accessory** — Instruction manual.

**ORDERING INFORMATION**

**FG 501A** 2 MHz Function Generator ..... **$825**

**FG 502**




11 MHz Function Generator

## FG 502

**0.1 Hz to 11 MHz**

**Five Waveforms**

**VCF and Gated Burst**

The FG 502 Function Generator provides low-distortion sine, square, and triangle waveforms, and positive or negative ramps and pulses. Output frequency is continuously variable from 0.1 Hz to 11 MHz. The high frequency range from 1 MHz to 11 MHz permits the versatility of the function generator to be extended into the medium radio frequency range. VCF input permits the FG 502 to be used as a sweep generator or as an FM generator.

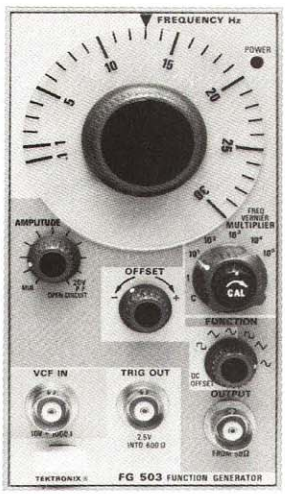
The external gate input permits the FG 502 output in any of its modes to be controlled by an externally supplied pulse to generate bursts of various output waveforms. This feature has application in wireless or radio remote control equipment and in certain phases of the telephone industry.

**Included Accessory** — Instruction manual.

**ORDERING INFORMATION**

**FG 502** 11 MHz Function Generator ..... **$980**

**FG 503**




3 MHz Function Generator

## FG 503

**1.0 Hz to 3 MHz**

**Three Waveforms**

**VCF**

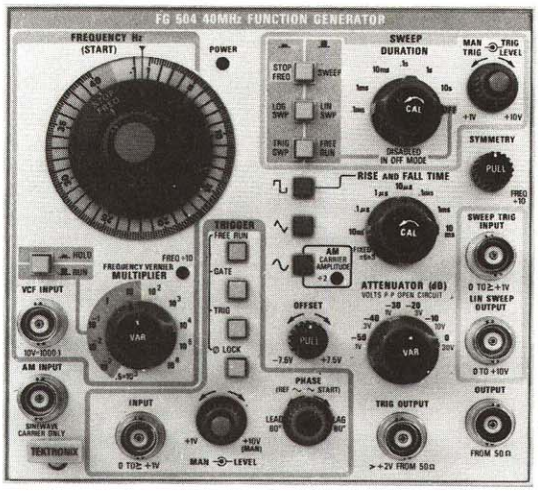
The FG 503 Function Generator provides high-quality low-distortion sine, square, and triangle waveforms. Six decade frequency multipler steps, a custom position for user-determined frequency multiplication, a dial calibrated from 1.0 to 30 (uncalibrated from 0.1 to 1.0), and a frequency vernier control work together to select frequencies in overlapping ranges from 1 Hz to 3 MHz. The output frequency may be swept over a 1000:1 ratio by an external voltage. Output amplitude and offset controls are provided. A trigger output is available for controlling external devices or equipment. Amplitude up to 10 V peak-to-peak can be developed across a 50 Ω load (20 V peak-to-peak open circuit). Selectable offset up to 3.75 V dc across 50 Ω (7.5 V dc open circuit) is also featured.

**Included Accessory** — Instruction manual.

**ORDERING INFORMATION**

**FG 503** 3 MHz Function Generator ..... **$610**

**FG 504**




**40 MHz Function Generator**

## FG 504

**0.001 Hz to 40 MHz**

**Three Basic Waveforms, Plus a Wide Range of Shaping with Variable Risetimes and Falltimes and Symmetry Controls**

**Logarithmic or Linear Sweep**

**Up to 30 V P-P Output**

**Built-In Attenuator**

**AM and FM**

**Phase Lock Mode**

**External and Manual Trigger or Gate**

**Counted Burst with DD 501**

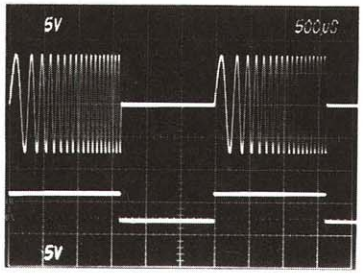
The output of the FG 504 may be phase locked, gated, or triggered by a reference signal, letting you convert from one waveform to another, such as pulses to sinewaves, as well as adjust phase relationships. Post attenuator offset enables use of the full ±7.5 V offset range with small signals. And the FG 504 output can be swept, or amplitude or frequency modulated by external signals. In addition, the FG 504 can supply internally generated linear or logarithmic swept frequencies of up to 1000:1 range with convenient control of start and stop frequencies.

The FG 504 also provides trigger output, external voltage control input, and sweep output.

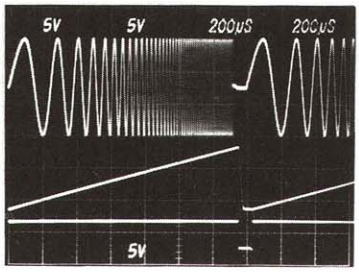
**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

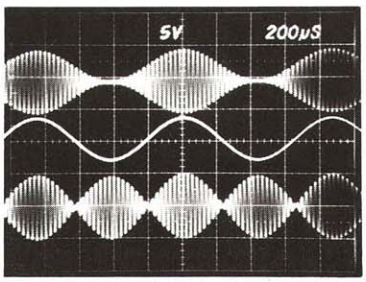
**FG 504** 40 MHz Function Generator . **$2,895**
**FG 504T** 40 MHz Function Generator . **$3,270**
(Includes FG 504, TM 503 Mainframe, and 016-0195-03 Blank Panel.)



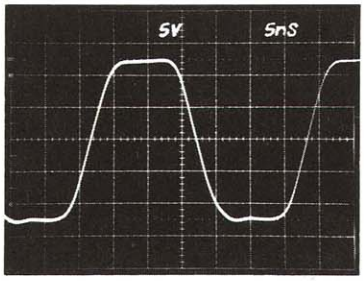

*FG 507 triggered sweep mode with output gated on by sweep gate.*




*FG 507 in logarithmic sweep with sweep ramp and gate outputs.*

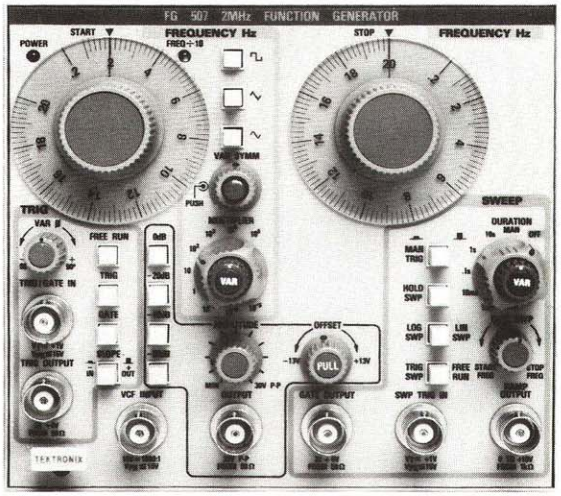



*True four quadrant multiplier permits normal am or double sideband suppressed carrier modulation.*




*FG 504 30 volt output with 6 ns risetime and falltime for superior pulse waveforms.*

**FG 507**




**2 MHz Sweeping Function Generator**

## FG 507

**0.002 Hz to 2 MHz**

**Includes All FG 501A Features**

**Logarithmic or Linear Sweep**

**Separate Start/Stop Frequency Dials**

**Sweep Up or Down**

**Sweep and Hold**

**Manual Sweep**

The FG 507 features the same basic performance as the FG 501A and adds flexible, easy-to-use log and linear sweep capability.

The log sweep of the FG 507 is mathematically correct and allows accurate frequency plots when using log scales, log paper, or a storage oscilloscope like the SC 503. Separate start and stop frequency dials make frequency settings easy to adjust and interpret. The instrument can be internally or externally swept up or down. A third frequency control allows you to manually sweep between the preset start and stop frequencies without disturbing their settings. This is especially convenient for examining frequency and amplitude anomalies of a circuit under test or in setting start and stop points. The sweep generator can be swept and the sweep gate output can be used to gate (burst) the generator on for swept bursts. The sweep hold mode allows the generator to sweep to the stop frequency and remain there until released.

The accurate log/linear sweep capability of the FG 507 plus the low distortion (0.25% over the audio range) make it ideally suited to audio testing.

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**FG 507** 2 MHz Sweeping Function Generator ..... **$1,520**

## PRODUCT SUMMARY

The TM 500 Digital Multimeter line consists of two general purpose instruments, the DM 501A and DM 502A. Both provide exceptional versatility in function and range. In addition to the usual ac and dc voltage, resistance, and ac/dc current functions, both meters offer a dB function and a platinum-resistance temperature-measurement function, which provides digital readout of the surface temperature in degree Centigrade.

The DM 501A and DM 502A each measure dc voltage to 1000 V, ac voltage to 500 V, both ac and dc current to 2 A, true RMS voltages, and resistance to 20 MΩ. The most significant differences are increased resolution provided by the extra digit on the DM 501A, increased temperature measurement range of the DM 501A and autoranging on the DM 502A.

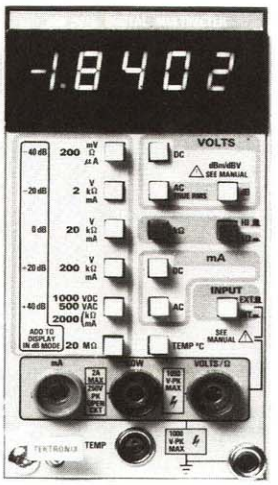
TM 500 digital multimeters offer a compact solution to your measurement needs without compromising wide performance range. The DM 501A and DM 502A provide accuracy and flexibility in laboratory bench, field service, and maintenance applications.

### DIGITAL MULTIMETER SELECTION GUIDE

| Model Number | DM 501A | DM 502A | DM 5010 |
|---|---|---|---|
| Number of Digits | 4½ | 3½ | 3½/4½*1 |
| Dc Volts Ranges | 200 mV to 1000 V | 200 mV to 1000 V | 200 mV to 1000 V |
| Dc Volts Accuracy | ±0.05% | ±0.1% | ±0.015% |
| Dc Volts Best Resolution | 10 μV | 100 μV | 10 μV |
| Ac Volts Ranges | 200 mV to 500 V | 200 mV to 500 V | 200 mV to 700 V |
| Ac Volts Accuracy | ±0.6% | ±0.6% | ±0.2% |
| Ac Volts Best Resolution | 10 μV | 100 μV | 10 μV |
| Ac or Dc Current Ranges | 200 μA to 2 A | 200 μA to 2 A | N/A |
| dB Ranges | +54 dB to −60 dB | +50 dB to −60 dB | Calculated |
| Resistance (HI-LO) Ranges | 200 Ω to 20 MΩ | 200 Ω to 20 MΩ | 200 Ω*2 to 20 MΩ |
| Temperature Range | −62°C to +240°C | −55°C to +200°C | N/A |
| True RMS | Yes | Yes | Yes |
| Auto Range | Yes | No | Yes |
| IEEE Standard 488 | No | No | Yes*3 |
| Mainframe Compatibility | TM 500 TM 5000 | TM 500 TM 5000 | TM 5000 |

*1 *Measurement rate of 3 readings/s at 4.5 digits, and 26 readings/s at 3.5 digits resolution.*
*2 *Low Ω plus diode test.*
*3 *Fully programmable, IEEE Standard 488 compatible. See page 358 for complete description.*

**DM 501A**




**Digital Multimeter**

# DM 501A

**0.05% dc Voltage Accuracy**

**7 Functions Including Temperature and dB**

**4½ Digits of Readout Resolution**

**True RMS Capability**

The DM 501A Digital Multimeter measures dc and ac voltage, dc and ac current, resistance, dB and temperature. The DM 501A gives 4½ digits of readout resolution. All with 0.05% accuracy and true RMS capability. True RMS allows accurate measurement of distorted waveforms. DB is useful when making critical audio and communication measurements. Fast accurate temperature measurements to 240°C come from the Tektronix P6601 platinum film temperature sensing probe. The P6601 reaches 90% of final reading in 1.5 seconds.

## CHARACTERISTICS

### DC VOLTS

**Ranges** — 200 mV, 2 V, 20 V, 200 V, and 1000 V.
**Accuracy*1**

| +18°C to +28°C | |
|---|---|
| 200 mV Range | ±[0.05% of reading +0.015% of full scale (3 counts)] |
| 2 V to 200 V Ranges | ±[0.05% of reading +0.01% of full scale (2 counts)] |
| 1000 V Range | ±[0.05% of reading +0.02% of full scale (2 counts)] |
| **0°C to +18°C and +28°C to +50°C** | |
| 200 mV to 200 V Ranges | ±[0.1% of reading +0.025 of full scale (5 counts)] |
| 1000 V Range | ±[0.1% of reading ±0.05% of full scale (5 counts)] |

*1 *Valid for a period of six months or 1000 hours, whichever occurs first.*

**Common-Mode Rejection Ratio** — ≥100 dB at dc. ≥80 dB at 50 Hz and 80 Hz with 1 kΩ imbalance.
**Normal-Mode Rejection Ratio** — ≥60 dB at 50 Hz or 60 Hz ±0.2 Hz.
**Maximum Resolution** — 10 μV.
**Step Response Time** — <1 s.
**Input Resistance** — 10 MΩ.
**Maximum Input Voltage** — 1000 V peak.

### TRUE RMS AC VOLTS

**Input Signal** — Must be between 5% and 100% of full scale.
**Ranges** — 200 mV, 2 V, 20 V, 200 V, and 500 V (ac coupled).
**Accuracy*1**

| +18°C to +28°C | | | | |
|---|---|---|---|---|
| | 20 Hz | 40 Hz | 10 kHz | 20 kHz |
| 200 mV to 200 V Ranges | ±[1% of reading +0.05% of full scale (10 counts)] | ±[0.6% of reading +0.05% of full scale (10 counts)] | ±[1% of reading +0.05% of full scale (10 counts)] | |
| 500 V Range | ±[1% of reading +0.2% of full scale (10 counts)] | ±[0.6% of reading +0.2% of full scale (10 counts)] | ±[1% of reading +0.2% of full scale (10 counts)] | |
| **0°C to +18°C and +28°C to +50°C** | | | | |
| | 20 Hz | 40 Hz | 10 kHz | 20 kHz |
| 200 mV to 200 V Ranges | ±[1.3% of reading +0.075% of full scale (15 counts)] | ±[0.8% of reading +0.075% of full scale (15 counts)] | ±[1.3% of reading of full scale +0.075% (15 counts)] | |
| 500 V Range | ±[1.3% of reading +0.3% of full scale (15 counts)] | ±[0.8% of reading +0.3% of full scale (15 counts)] | +[1.3% of reading +0.3% of full scale (15 counts)] | |

*1 *Valid for a period of six months or 1000 hours whichever occurs first.*

**Common-Mode Rejection Ratio** — ≥60 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.
**Maximum Resolution** — 10 μV.
**Response Time** — <2 s.
**Input Impedance** — 10 MΩ paralleled by 160 pF.
**Maximum Input Voltage** — 500 V ac RMS, 600 V dc, not to exceed 1000 V peak.
**Crest Factor** — 4 (at full scale).

### dB (TRUE RMS)

**Zero dB Reference** — 1 mW in 600 Ω (0.775 V) (dBm) Internal jumper change for 0 dB reference of 1.0000 V (dBV).
**Accuracy*1**

| +18°C to +28°C | | | |
|---|---|---|---|
| 20 Hz | 2 kHz | 10 kHz | 20 kHz |
| +50 dB to −50 dB | 0 | ±0.5 dB | |
| −50 dB to −60 dB | ±0.5 dB | ±1.5 dB | Typically ±2.5 dB |

*1 *From 0°C to +18°C and +28°C to +50°C, add 0.6 dB to above accuracy specifications.*

**Maximum Resolution** — 0.1 dB.
**Response Time** — <2 s.
**Input Impedance** — 10 MΩ paralleled by <160 pF.
**Maximum Input Voltage** — 500 V RMS, not to exceed 1000 V peak. Equivalent to +54 dBV or +56.2 dBm.
**Crest Factor** — 4 (at full scale).

### RESISTANCE

**Response Time** — <2 s in 200 Ω to 2000 kΩ ranges; <10 s in 20 MΩ range.
**Maximum Input Volts** — 250 V peak.
**Maximum Resolution** — 10 mΩ.
**HI-LO Ohm Operation** — A low voltage is user-selectable for making in-circuit ohms measurements without turning on silicon diode and transistor junctions. A high voltage is also available for testing junctions for forward and reverse resistance.

**Maximum Open-Circuit Voltage Developed** — <6 V.
**Ranges** — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, and 20 MΩ.
**Accuracy**[*1]

| +18°C to +28°C | | |
|---|---|---|
| 200 Ω Range | LO Ω | ±[0.15% of reading +0.015% of full scale (3 counts)] |
| 2 kΩ to 2000 kΩ Ranges | HI Ω | ±[0.15% of reading +0.015% of full scale (3 counts)] |
| 2 kΩ to 200 kΩ Ranges | LO Ω | ±[0.15% of reading +0.015% of full scale (3 counts)] |
| 2000 kΩ Range | LO Ω | ±[0.3% of reading +0.015% of full scale (3 counts)] |
| 20 MΩ Range | HI Ω only | ±[0.5% of reading +0.015% of full scale (3 counts)] |
| **0°C to +18°C and +28°C to +50°C** | | |
| 200 Ω Range | LO Ω | ±[0.3% of reading +0.025% of full scale (5 counts)] |
| 2 kΩ to 2000 kΩ Ranges | HI Ω | ±[0.3% of reading +0.025% of full scale (5 count)] |
| 2 kΩ to 200 kΩ Ranges | LO Ω | ±[0.3% of reading +0.025% of full scale (5 counts)] |
| 20 MΩ Range LO Ω 2000 kΩ Range | HI Ω | ±[1.2% of reading +0.025% of full scale (5 counts)] |

*[*1] Valid for six months or 1000 hours whichever occurs first.*

**DC AND TRUE RMS AC CURRENT**

**Input Signal** — Must be between 5% and 100% of full scale (ac only).
**Ranges** — 200 μA, 2 mA, 20 mA, 200 mA, and 2000 mA.
**Dc Current Accuracy** — +18°C to +28°C: ±[0.2% of reading +0.015% of full scale (3 counts)]. 0°C to +18°C and +28°C to +50°C: ±[0.3% of reading + 0.025% of full scale (5 counts)].
**Ac Current Accuracy** — From 20 Hz to 10 kHz. +18°C to +28°C: ±[0.6% of reading +0.05% of full scale (10 counts)]. 0°C to +18°C and +28°C to +50°C: ±[0.7% of reading +0.075% of full scale (15 counts)]. Usable to 20 kHz.
**Response Time** — <1 s dc current, <2 s ac current.

| Range | Approximate Resistance |
|---|---|
| 200 μA | 1.0 kΩ |
| 2 mA | 100.0 Ω |
| 20 mA | 10.2 Ω |
| 200 mA | 1.2 Ω |
| 2000 mA | 0.4 Ω |

**Maximum Open-Circuit Input Voltage (mA to LOW)** — 250 V peak, fused with 2 A fast blow.
**Maximum Floating Voltage** — 1000 V peak.
**Maximum Resolution** — 10 nA.

**TEMPERATURE**

**Range** — −62°C to +240°C.
**Resolution** — 0.1°C.
**Accuracy**[*1]

| Temperature to be measured | −62°C | +150°C | +240°C |
|---|---|---|---|
| P6601 and DM 501A calibrated as a pair | ±2°C | 0°C to −6°C | |
| P6601 and instrument not calibrated as a pair | ±4°C | +2°C to −8°C | |

*[*1] +18° C to +28° C ambient temperature. For 0° C to +18° C and +28° C to +50° C ambient temperatures, add 1.5° C to above limit in each direction.*

**OTHER CHARACTERISTICS**

**Overrange Indication** — Blinking display (except on 1000 V dc and 500 V ac ranges).
**Measurement Rate** — 3⅓/s.
**Power Consumption** — ≈9 W.
**Inputs** — Maximum input voltage is 1000 V. The front panel Volts/Ω, or Low, or mA terminals can be floated to 1000 V peak maximum above ground, the rear input only 200 V peak. For the rear input, ac volts, ohms, and maximum input specfications are derated.

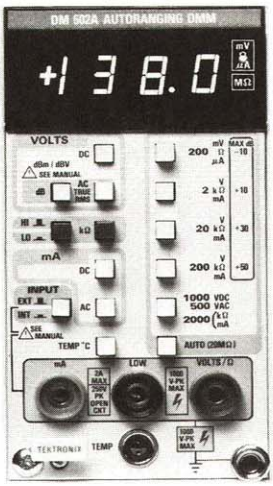
**INCLUDED ACCESSORIES**

One pair of test leads (003-0120-00); P6601 Temperature Probe (010-6601-01); instruction manual.

## ORDERING INFORMATION

**DM 501A** Digital Multimeter ..... **$745**
**Option 02** — (Deletes P6601 Temperature Probe and temperature measurement capability) ..... **$100**

## DM 502A




**Digital Multimeter**

# DM 502A

**True RMS**

**Autoranging**

**7 Functions Including Temperature and dB**

**0.1% Dc Volts Accuracy**

**3½ Digit Display**

The DM 502A Digital Multimeter measures seven different functions with pushbutton convenience. Autoranging, in all modes except current, eliminates any need for operator selected ranges. The DM 502A measures dc and ac voltage, dc and ac current, dB, resistance and temperature. True RMS provides more accuracy in ac measurements on distorted, noisy, random or other nonsinusoidal ac waveforms. The resistance mode features HI-LO voltage (2 V to 0.2 V). The low voltage is user-selectable for making in-circuit ohms measurements without turning on diode and transistor junctions. The high voltage is available for testing junctions for forward and reverse resistance. The LED indicators provide a bright, readable 3½ digit display.

## CHARACTERISTICS

**DC VOLTS**

**Ranges** — 2000 mV, 2 V, 20 V, 200 V, and 1000 V. Automatic or manual ranging.
**Accuracy**[*1]

| −18° to +28°C | Normal and Fast Conversion Rate |
|---|---|
| 20 mV to 200 V | ±[0.1% of reading +0.05% of full scale (1 count)] |
| 1000 V | ±[0.1% of reading +0.1% of full scale (1 count)] |
| **0°C to +18°C, +28°C to +50°C** | |
| | **Normal and Fast Conversion Rate** |
| 200 mV to 200 V | ±[0.2% of reading +0.1% of full scale (2 counts)] |
| 1000 V Range | ±[0.2% of reading +0.2% of full scale (2 counts)] |

*[*1] Valid for a period of six months or 1000 hours, whichever occurs first.*

**Common-Mode Rejection Ratio** — ≥100 dB at dc. ≤80 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.
**Normal-Mode Rejection Ratio** — ≥50 dB at 50 Hz or 60 Hz ±0.2 Hz.
**Maximum Resolution** — 100 μV.
**Step Response Time** — 1 s within a range, +1.5 s for each range change in autoranging mode.
**Input Resistance** — 10 MΩ.
**Maximum Input Voltage** — 1000 V peak.

**TRUE RMS AC VOLTS**

**Ranges** — 200 mV, 2 V, 20 V, 200 V, and 500 V. Automatic or manual ranging (ac coupled).
**Accuracy**[*1]

| 0°C to +18°C | Normal and Fast Conversion Rate | | |
|---|---|---|---|
| | 20 Hz | 40 Hz | 20 kHz |
| 200 mV to 200 V | ±[1.5% of reading +0.3% of full scale (6 counts)] | ±[0.6% of reading +0.3% of full scale (6 counts)] | |
| 500 V | ±[1.5% of reading +1.2% of full scale (6 counts)] | ±[0.6% of reading +1.2% of full scale (6 counts)] | |
| **0°C to +18°C, +28°C to +50°C** | **Normal and Fast Conversion Rate** | | |
| | **20 Hz** | **40 Hz** | **20 kHz** |
| 200 mV to 200 V Range | ±[1.8% of reading +0.35% of full scale (7 counts)] | ±[0.8% of reading +0.35% of full scale (7 counts)] | |
| 500 V Range | ±[1.8% of reading +1.4% of full scale (7 counts)] | ±[0.8% of reading +1.4% of full scale (7 counts)] | |

*[*1] Valid for a period of six months or 1000 hours whichever occurs first. Typically usable to 100 kHz.*

**Common-Mode Rejection Ratio** — ≥60 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.
**Maximum Resolution** — 100 μV.
**Resolution Time** — 1 s within a range, +1.5 s for each range change in autoranging mode.
**Input impedance** — 10 MΩ paralleled by <100 pF.
**Maximum Input Voltage** — 500 V ac RMS, 600 V dc, not to exceed 1000 V peak.
**Crest Factor** — 4 (at full scale all ranges), ≤2 on 500 V range.

**dB (TRUE RMS)**

**Zero dB Reference** — 1 mW in 600 Ω (0.775 V) (dBm). Internal jumper change for 0 dB reference of 1,000 V (dBV).
**Accuracy**[*1]

| +18°C to +28°C | 20 Hz | 2 kHz | 10 kHz | 20 kHz |
|---|---|---|---|---|
| +50 dB to −50 dB | ±0.5 dB | | | |
| −50 dB to −60 dB | ±0.5 dB | ±1.5 dB | Typically ±2.5 dB | |

*[*1] From 0° C to +18° C and +28° C to +50° C, add 0.6 dB to above accuracy specifications. For example, at 0° C the accuracy in the +50 dB to −50 dB range from 20 Hz to 20 kHz would be ±1.1 dB.*

**Noise Level** — Typically −75 dB.
**Maximum Resolution** — 0.1 dB.
**Response Time** — ≤1 s within a range, ≤1.5 s for each range change in autoranging mode.
**Input Impedance** — 10 MΩ paralleled by <100 pF.
**Maximum Input Voltage** — 500 V RMS, not to exceed 1000 V peak.
**Crest Factor** — 4 (at full scale), ≤2 above 40 dB.

### RESISTANCE

**Ranges** — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, and 20 MΩ. Automatic or manual ranging.

**Accuracy**[*1]

| +18°C to +28°C | |
|---|---|
| 200 Ω to 2000 kΩ Ranges | ±[0.5% of reading +0.05% of full scale (1 count) + 0.2 Ω] |
| 20 MΩ Range | ±[1% of reading +0.05% of full scale (1 count)] |
| **0°C to +18°C and +28°C to +50°C** | |
| 200 Ω to 2000 kΩ Ranges | ±[0.8% of reading +0.1% of full scale (2 counts) + 0.2 Ω] |
| 20 MΩ Range | ±[1.3% of reading +0.1% of full scale (2 counts)] |

*[*1] Valid for a period of six months or 1000 hours whichever occurs first.*

**Response Time** — ≤1 s within a range, ≤1.5 s for each range change in autoranging mode.

**Maximum Input Volts** — 130 V dc or ac RMS indefinitely. 230 V dc or ac RMS for 30 minutes maximum.

**HI-LO Ohms Operation** — A low voltage is user-selectable for making in-circuit ohms measurements without turning on silicon diode and transistor junctions. A high voltage is also available for testing junctions for forward and reverse resistance.

**Maximum Resolution** — 0.1 Ω.

**Maximum Open-Circuit Voltage Developed** — ≈14 V.

### DC AND TRUE RMS AC CURRENT

**Ranges** — 200 μA, 2 mA, 20 mA, 200 mA, and 2000 mA. Manual ranging only.

**Dc Current Accuracy** — +18°C to +28°C: ± [0.2% of reading +0.05% of full scale (1 count)]. 0°C to +18°C and +28°C to +50°C: ± [0.3% of reading +0.1% of full scale (2 counts)].

**Ac Current Accuracy (From 40 Hz to 10 kHz)** — Usable to 20 kHz. +18°C to +28°C: ±[0.6% of reading +0.3% of full scale (6 counts)]. 0°C to +18°C and +28°C to +50°C: ±[0.7% of reading +0.5% of full scale (10 counts)].

**Input Resistance**

| Ranges | Approximate Resistance |
|---|---|
| 200 μA | 1.0 kΩ |
| 2 mA | 100.0 Ω |
| 20 mA | 10.2 Ω |
| 200 mA | 1.2 Ω |
| 2000 mA | 0.4 Ω |

**Response Time** — ≤1 s.

**Maximum Open Circuit Input Voltage (mA to LOW)** — 250 V peak, fused with 2 A fast blow.

**Maximum Floating Voltage** — 1000 V peak.

**Maximum Resolution** — 0.1 μA.

### TEMPERATURE

**Range** — −55°C to +200°C.

**Resolution** — 0.1°C.

**Accuracy**[*1]

| +18°C to +28°C | | | |
|---|---|---|---|
| **Temperature to be Measured** | **−55°C** | **+150°C** | **+200°C** |
| P6601 Probe and DM 502A calibrated as a pair | ±2.5°C | | ±3.5°C |
| P6601 and instrument not calibrated as a pair | ±4.5°C | | ±5.5°C |

*[*1] For 0° C to +18° C and +28° C to +50° C ambient temperatures, add ±1.5° C to accuracy specifications.*

### OTHER CHARACTERISTICS

**Overrange Indication** — Blinking display (except 1000 V dc and 500 V ac).

**Measurement Rate** — Three per second.

**Power Consumption** — ≈8 W.

**Inputs** — Maximum input voltage is 1000 V. The front panel V/Ω, or Low, or mA terminal can be floated 1000 V peak maximum above ground, the rear input 200 V peak. For the rear input, ac volts, ohms and maximum input specifications are derated.

### INCLUDED ACCESSORIES

One pair test leads (003-0120-00); P6601 Temperature Probe (010-6601-01); instruction manual.

### ORDERING INFORMATION

**DM 502A** Digital Multimeter ..... **$690**
**Option 02** — (Deletes temperature probe and capability.) ..... **$100**

## DIGITAL MULTIMETER PROBES & OPTIONAL ACCESSORIES

### High Voltage Probe

The High Voltage Probe will measure dc voltages from 1 kV to 40 kV with an accuracy of 1% at 25 kV. The division ratio is 1000:1. Common uses include measuring anode voltages on monitors or oscilloscopes. Probe plugs directly into the front end of the multimeter.

### CHARACTERISTICS

**Voltage Range** — 1 kV to 40 kV dc.
**Input Resistance** — 1000 MΩ.
**Division Ratio** — 1000:1.
**Overall Accuracy** — 20 kV to 30 kV 2%.
**Upper Limit Accuracy** — Changes linear from 2% at 30 kV to 4% at 40 kV.
**Lower Limit Accuracy** — Changes linear from 2% at 20 kV to 4% at 1 kV.
**Input Z at Meter** — 10 MΩ required.
**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**High Voltage Probe.** Order 010-0277-00 ..... **$165**

### P6420 RF Probe

The P6420 RF Probe is compatible with DMM's that have an input impedance of 10 MΩ and comes with a two meter cable.

### CHARACTERISTICS

**Voltage Range** — 5 V to 25 V RMS (70.7 V p-p).
**Ac to Dc Transfer Ratio Accuracy** — 0.5 V to 5 V RMS ±10% (+15°C to +35°C). 5.0 V to 25 V RMS ±5% (+15°C to +35°C).
**Frequency Response** — 100 kHz to 300 MHz (±0.5 dB), 50 kHz to 500 MHz (±1.5 dB), 10 kHz to 1 GHz (±3.0 dB).
**Input Capacitance** — ≈3.7 pF.
**Maximum Input Voltage** — 42.4 V (peak ac + dc).
**Length** — Probe only 96 mm. Cable only 2 meters.

### INCLUDED ACCESSORIES

Retractable probe tip (013-0097-01); BNC female to dual banana adaptor (103-0090-00); alligator clip (344-0046-00); probe holder (352-0351-00); 76.2 mm (3 in) ground lead (175-0849-00); 152.8 mm (6 in) ground lead (175-1017-00); two replaceable probe tips*[1]; electrical insulating sleeve (166-0404-01); instruction manual.

*[*1] Available in package of ten only, Order 206-0230-03.*

### ORDERING INFORMATION

**P6420** RF Probe, 2 m Cable Included. Order 010-6420-03 ..... **$145**
**For a 1 Meter Length Cable** (does not change specifications). Order 175-1661-00 ..... **$27**
**For a 3 Meter Length Cable** (does not change specifications). Order 175-1661-02 ..... **$27**

### P6601 Temperature Probe

The P6601 Probe is a temperature measuring device designed to operate with the DM 502A and DM 501A Digital Multimeters. The temperature sensing element consists of a thin-film platinum resistor on the tip of the probe. Measurements are made by touching the probe tip to the surface whose temperature is in question. The thermal signal is transmitted to the associated digital multimeter through a two-conductor cable.

The thermal time constant on the P6601 Probe is 0.5 seconds ±0.2 seconds. The P6601 is totally immersible except in liquids that are not compatible with Dow Corning 308 molding compound, BeO, silicone rubber, or epoxy adhesives. The sensor and tip are limited to a maximum of +240°C, and cable is limited to a maximum of +140°C.

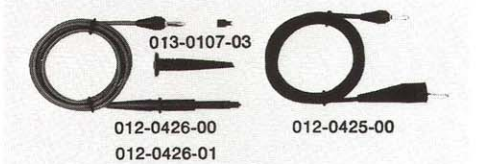
**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**P6601** Temperature Probe. Order 010-6601-01 ..... **$210**

## DMM OPTIONAL ACCESSORIES

The following accessories may be ordered as options for use with any of the three TM 500/TM 5000 Digital Multimeters.




**Test Lead** — Black, 4 ft. Order 012-0425-00 ..... **$12**
**Test Lead** — Red, 4 ft. Order 012-0426-00 ..... **$22**
**Test Lead** — Black, 4 ft. Order 012-0426-01 ..... **$22**
**Test Lead** — Set (012-0425-00, 012-0426-00, 013-0107-03). Order 012-0427-00 ..... **$29**
**Adaptor** — Female BNC to Dual Banana. Order 103-0090-00 ..... **$7.50**

Additional accessories begin on page 438.

The TM 500 Pulse Generator family offers a wide variety of capabilities suitable for most pulse testing applications. Whether testing wide-band systems, simulating data transmission signals, or driving a laser, the versatile TM 500 Pulse Generators have the capabilities to meet your needs.

Particularly important in today's digital world is the capability to generate a variety of pulse signals compatible with the key logic families.

The PG 507 features complementary dual outputs making it ideally suited for digital applications. The dual output feature is particularly useful when working with ECL logic families.

Similar to the PG 507 Pulse Generator is the 50 MHz PG 508 featuring independently variable risetimes and falltimes. The PG 508's high level performance and versatility cover a broad range of test and measurement applications.

The accurate 50 ohm output impedances of the PG 507 and PG 508 deliver clean signals into logic families, reactive loads, or at the end of an unterminated cable. These 50 MHz multipurpose generators are also designed for high level performance on high impedance circuits (MOS, HTL, and CMOS logic).

In 50 ohm systems, the PG 501 and PG 502 are designed to be compatible with common digital integrated-circuit families (TTL, DTL and ECL), in repetition rates, amplitudes and transition times.

The TM 500 Pulse Generators' wide range of features afford you ease of operation even on the most challenging test and measurement problems.

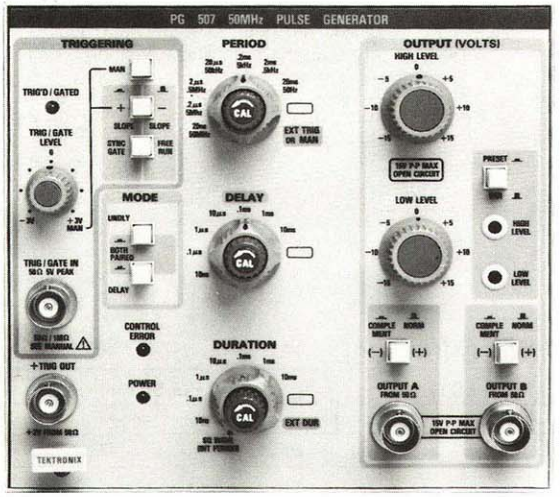
## PULSE GENERATORS COMPARISON OF CHARACTERISTICS

| | PG 507 | PG 508 | PG 501 | PG 502 |
|---|---|---|---|---|
| **Pulse Period** | ≤20 ns to ≥200 ms (50 MHz to 5 Hz) | | ≤20 ns to ≥200 ms (50 MHz to 5 Hz) | ≤4 ns to ≥100 ms (250 MHz to 10 Hz) |
| **Pulse Duration Duty Factor** | ≤10 ns to ≥100 ms | | ≤10 ns to ≥100 ms | ≤2 ns to ≥50 ms |
| | ≥70% to 0.2 μs period, ≥50% at 20 ns period | | | ≥50% |
| **Squarewave Mode** | Yes | Yes | No | Yes |
| **Pulse Delay Duty Factor** | ≤10 ns to ≥100 ms*1 | ≤10 ns to ≥100 ms*1 | | |
| | ≥70% to 0.2 μs period, ≥50% at 20 ns period | | Fixed, 20 ns from external trigger | Fixed, 17 ns from external trigger |
| **Double Pulse** | Yes | Yes | No | No |
| **Transition Times** | Fixed, ≤3.5 ns, ≤4 ns @ >5 V | ≤5.5 ns to ≥50 ms, Independently variable up to 100:1 | Fixed, ≤3.5 ns | Fixed ≤1.0 ns |
| **Aberrations** | ≤5% p-p +25 mV into 50 Ω load | ≤5% p-p +50 mV for pulse within ±5 V into 50 Ω load | Within 3.5% at 5 V into 50 Ω load | Within 5% at 5 V p-p (durations ≥5 ns) |
| **Amplitude: Into 50 Ω** | ≥7.5 V p-p, ±7.5 V window | ≥10 p-p, ±10 V window | ≥5 V | 5 V, ±5 V window |
| **Open Circuit** | ≥15 V p-p, ±15 V window | ≥20 p-p, ±20 V window | Not specified | 5 V, ±5 V window |
| **Source Impedance** | 50 Ω | 50 Ω | Not specified | 1 kΩ or 50 Ω |
| **Simultaneous Outputs** | Yes, complementary | No | Yes, positive and negative | No |
| **Pulse Coincidence** | ≤1 ns at 50% amplitude | NA | ≤1 ns at 50% amplitude | NA |
| **Output Controls** | Independent pulse top and pulse bottom, normal or PRESET | | Independent amplitude controls for + and − outputs, no offset | Independent pulse top and pulse bottom |
| **Normal/Complement** | Yes, both outputs | Yes | No | Yes |
| **Remote Amplitude** | Rear interface inputs | Rear interface inputs | No | No |
| **Locked On Mode** | No | No | Yes | No |
| **Back Termination** | Always back terminated | Always back terminated | No | Yes, switchable |
| **External Input** | 1 MΩ to 50 Ω input impedance | 1 MΩ or 50 Ω input impedance | 50 Ω input Z | 50 Ω input Z |
| **Trigger Level** | −3 V to +3 V, 80 mV p-p sensitivity to 10 MHz<br>250 mV p-p to 50 MHz TRIG'D/GATED light | | +1 V required | +1 V required |
| **Slope** | + or − | + or − | + Only | + Only |
| **Trigger Mode** | Yes | Yes | Yes | Yes |
| **Manual Trigger** | Yes | Yes | No | Yes |
| **Duration Mode** | Yes | Yes | Yes | Yes |
| **Gate Mode** | Yes | Yes | No | No |
| **Counted Burst** | Yes, with DD 501*2 | Yes, with DD 501*2 | No | No |
| **Trigger Output (50% Squarewave or Follows External Signal)** | ≥+2 V from 50 Ω approximately 35 ns prior to pulse output (23 ns in squarewave or EXT DUR modes) | | ≥+2 V from 50 Ω, approximately 8 ns prior to pulse output | ≥+2 V from 50 Ω, approximately 10 ns prior to pulse output |
| **Custom Timing Positions** | User installed capacitors | User installed capacitors | No | No |
| **Control Error Light** | Yes | Yes | No | No |

*1 *Add 60 ns for delay from external trigger.*
*2 *Exact count to 20 MHz, usable to 50 MHz.*

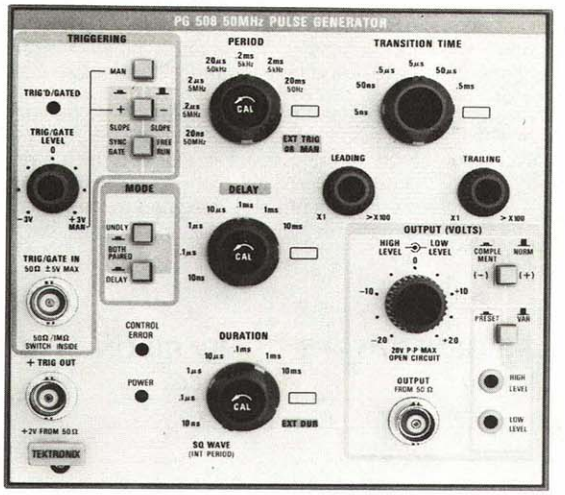
For recommended accessories — refer to page 458.

**PG 507**



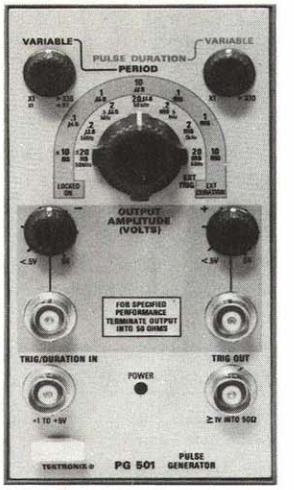

**50 MHz Dual Output Pulse Generator**

**PG 508**




**50 MHz Pulse Generator**

**PG 501**




**50 MHz Pulse Generator**

## PG 507

**Dual Outputs with Tracking Level Controls**

**Normal or Complement Pulse Output on Both Channels**

**15 V Output in a ±15 V Window into High Impedance, 7.5 V into 50 Ω**

**3.5 ns Risetime/Falltime**

The PG 507 is a high performance, 50 MHz pulse generator designed specifically for logic design applications.

The PG 507 features complementary dual outputs which greatly increase its applicability in logic design areas, especially interfacing within systems or to peripherals. For instance, the complementary outputs allow simulation of line drivers or opposite phase clocks.

The PG 507 also offers versatility to the design engineer in an analog environment. For example, the dual outputs can be used to test differential input amplifiers or multiplexers.

The PG 507 features four output modes: normal complement mode (Channel A output positive going, Channel B output negative going), opposite phase complement mode (Channel A output negative going, Channel B output positive going), simultaneous negative mode (Channel A output negative going, Channel B output negative going), and simultaneous positive mode (Channel A positive going Channel B output positive going).

In addition, the Output High Level and Low Level voltage controls track between channels, making amplitude settings easy.

This unique output flexibility within the normal and complement modes is particularly useful in logic design or control applications requiring simultaneous signals.

**Included Accessory** — Instruction manual.

**ORDERING INFORMATION**

**PG 507** 50 MHz Pulse Generator ..... **$2,185**

**P6062B, P6108 and P6122 Probes are recommended, see pages 454, 450 and 451 respectively.**

## PG 508

**Independently Variable Risetimes and Falltimes to 5 ns**

**20 V Output in a ±20 V Window to Hi Impedance, 10 V into 50 Ω**

**Normal or Complement Output**

The PG 508 50 MHz Pulse Generator is a highly versatile, general purpose pulse generator. The circuitry of the PG 508 is designed so that rise and fall waveforms closely simulate real world waveforms. This capability is particularly useful in research and development applications demanding versatility in risetimes and falltimes like testing of amplifiers, slew rate testing, comparator simulation and logic circuitry performance tests.

For example, controllable risetimes and falltimes are extremely desirable when working with CMOS where logic power consumption increases with slower risetimes. Also, variable risetimes and falltimes are used to reduce ringing (transient distortion) problems associated with too fast a pulse.

The PG 508 features a vernier control on the risetimes and falltimes controllable from 100 to 1. This completely overlaps the next decade range and increases the PG 508's versatility in applications simulating different risetimes and falltimes, especially the output of nonlinear devices. This overlap feature can also be used to generate a ramp signal or simulate unequal slew rates in an amplifier.

Also adding to the simplicity of using the PG 508 is the capability of changing output amplitude while variable risetimes and falltimes remain constant.

**Included Accessory** — Instruction manual.

**ORDERING INFORMATION**

**PG 508** 50 MHz Pulse Generator ..... **$2,140**

**PG 508T** 50 MHz Pulse Generator ..... **$2,515**

(Includes PG 508, TM 503 Mainframe, and 016-0195-03 Blank Panel.)

**For counted Burst, order the**

**DD 501** Digital Delay (page 383) ..... **$1,385**

Suggested 10 in BNC 50 Ω cable (2 required) for interconnecting PG 508 and DD 501: **Order 012-0208-00** ..... **$22**

**P6062B, P6108 and P6122 Probes are recommended, see pages 454, 450 and 451 respectively.**

## PG 501

**5 Hz to 50 MHz**

**Simultaneous Plus and Minus Outputs**

**5 V and 3.5 ns into 50 Ω**

**Independent Period and Duration Controls**

**Trigger Out**

The PG 501 is a 50 MHz Pulse Generator featuring simultaneous plus and minus outputs, a wide range of pulse-period durations and duty factors, trigger output and external trigger/duration input. Its performance and ease of operation make it well-suited to basic digital and analog applications.

**Included Accessory** — Instruction manual.

**ORDERING INFORMATION**

**PG 501** 50 MHz Pulse Generator ..... **$780**

**Manual (One-Shot) Trigger Generator**

The Manual (one-shot) Trigger Generator is used for manually initiating a pulse or complete train of events with instruments which do not have a manual trigger button or where a remote operation capability is desired, such as with some oscilloscopes and the PG 501.

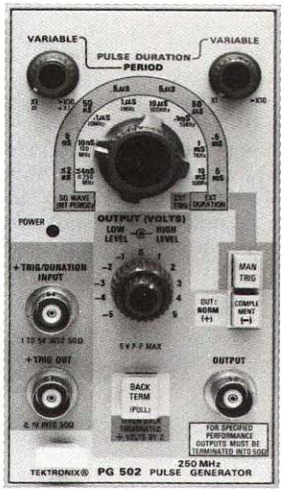
The internal trigger generator circuitry eliminates contact bounce, but will generate pulses as rapidly as the operator can manually cycle the pushbutton.

The output pulse is nominally 2 ms in width and 3 V in amplitude (from 50 Ω) with a rapid risetime and falltime.

**ORDERING INFORMATION**

**Trigger Generator** 016-0597-00 ..... **$170**

PG 502

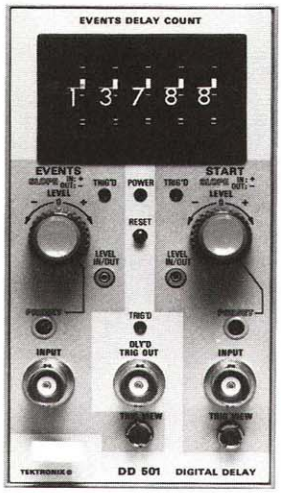



250 MHz Pulse Generator

284

Pulse Generator

DD 501




Digital Delay

## PG 502

**10 Hz to 250 MHz**

**1 ns Risetime**

**5 V Output ±5 V Window**

**Independent Pulse Top and Bottom Level Controls**

**Selectable Internal Reverse Termination**

**Manual Trigger Button**

The PG 502 features fast risetimes and falltimes, independent top and bottom pulse levels, and adjustable pulse duration. The fast rep rate makes the instrument ideal for design and testing of fast logic and switching circuits.

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**PG 502** 250 MHz Pulse Generator ..... **$2,750**

**50 Ω Precision Coaxial Cable**

For use with the PG 502, PG 506, and SG 503. These instruments are internally calibrated for use with this 3 ft 50 Ω coaxial cable into a 50 Ω load.

### ORDERING INFORMATION

**50 Ω Cable** Order 012-0482-00 ..... **$25**

## 284

**70 ps or Less Risetime Pulse**

**Sinewave and Squarewave Outputs**

### CHARACTERISTICS

**Pulse Output** — 70 ps or less risetime with a pulse width of more than 1 μs and a repetition rate of ≈50 kHz. Aberrations immediately following positive-going transitions are < ±3%, 3% total p-p; after 2 ns < ±2%, 2% total p-p. Pulse amplitude is more than +200 mV into 50 Ω. Source resistance is 50 Ω.

**Squarewave Output** — Periods of 10 μs, 1 μs, or 100 ns. Amplitude is 10 mV, 100 mV, or 1 V into 50 Ω.

**Sinewave Output** — Periods of 10 ns or 1 ns. Output amplitude is 100 mV into 50 Ω.

**Trigger Output** — Squarewave, sinewave, or pretrigger pulse output, depending on the selected main signal output. Amplitude is 200 mV, accurate within 40%. When Pulse Output is selected, the trigger can be switched to arrive 5 ns ±5 ns, or 75 ns ±5 ns ahead of the main pulse. Risetime is 3 ns or less; pulse width is 10 ns or greater.

| Output | Period | Timing Accuracy | Amplitude Accuracy 1 V | 100 mV | 10 mV |
|---|---|---|---|---|---|
| Pulse | 20 μs | ±10% | | | |
| Square-wave | 10 μs<br>1 μs | ±0.5% | ±0.5% | ±1% | ±1.5% |
| | 100 ns | ±0.05%*1 | ±2%*2 | ±2.5%*2 | ±3%*2 |
| Sinewave | 10 ns<br>1 ns | ±1% | | ±20% | |

*1 *Crystal controlled.*
*2 *20 ns after transition.*

The 284 is not part of the TM 500 Series, and does not require the use of a separate mainframe.

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**284** Pulse Generator ..... **$2,000**

## DD 501

**Digital Events Delay**

**Delay to 99,999 Events**

**Divide by N up to 20 MHz**

**Pulse Counting to 65 MHz**

**Time Delay with Ext Clock**

**Compatible with Most Attenuator Probes**

The DD 501 Digital Delay is an events-counting device which can be used with pulse, function and clock generators in such applications as precise digital delay between two related events, divide-by-N frequency divider, precision gate generator, counted burst output from a gated pulse or frequency generator, etc.

The DD 501 has basically two modes of operation. In the gating mode, the DD 501 generates a gate which starts with the application of a start pulse and continues until a selected number of event pulses have occurred. It can be used for generating a counted burst of N pulses when used with a pulse generator capable of being gated. Tektronix generators capable of being gated by the DD 501 are the FG 501A, FG 502, FG 504, FG 507, FG 5010, PG 507, and PG 508.

In the delayed trigger mode, the DD 501 generates a trigger pulse after the selected number of event pulses have occurred. Besides being used strictly for generating precision delays, the delayed trigger mode can also be used as a frequency count-down divider for any frequency up to 65 MHz. In both modes, the desired number of events (from 0 to 99,999) is selected by front-panel thumbwheel switches.

Trigger slope and level controls for both the Start and Events inputs permit use with a wide variety of applied signals. Both inputs are compatible with Tektronix attenuator probes. In special applications, the trigger levels may be remotely set by application of analog voltages through the front-panel Level In/Out jacks.

### CHARACTERISTICS

#### EVENTS DELAY

**Count** — 10 to 99,999 events.
**Maximum Count Rate** — 65 MHz.
**Insertion Delay** — 30 ns or less from final event to trigger output pulse.
**Recycle Time** — 50 ns or less.
**Reset** — Manually resets delay counter.

#### INPUT CHARACTERISTICS

(All characteristics apply to both events and start inputs).
**Input Impedance** — 1 MΩ, 20 pF.
**Slope** — Either + or −, selectable.
**Sensitivity** — 85 mV p-p at 30 MHz.
**Frequency Response** — Up to 65 MHz at 120 mV sensitivity.
**Minimum Detectable Pulse Width** — 5 ns,
**Threshold Level Range** — From −1.0 V to +1.0 V (−10 V to +10 V with 10X probe). Can be externally programmed or monitored at front panel jacks.
**Trigger View Out** — Threshold detector output, at least 0.5 V (200 Ω or less source impedance).
**Events Triggered Light** — Visual indication that events are being detected.
**Start Triggered Light** — Visual indication that delay is in progress.

#### TRIGGER OUTPUT

**Pulse Width** — Width of events pulse plus 6 ns or less.
**Voltage Swing** — +0.8 V or less to at least +2.0 V with 3 TTL loads (≈5 mA).
**Light** — Indicates output trigger.
**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**DD 501** Digital Delay ..... **$1,385**

## PRODUCT SUMMARY

Design engineers require power supplies that are flexible enough to meet their needs...and compact enough to allow a complete, custom-designed test system to fit neatly on a crowded workbench. To assure versatility and convenience in your test system, the TM 500 power supplies can be rear interfaced with other instruments to reduce front panel clutter while providing capabilities not otherwise available. For example, the output level can be monitored via the rear interface by a companion TM 500 digital multimeter without the need for extra cabling at the front of the instrument. Remote sensing terminals available at the rear panel allow sensing of the applied voltage at the load, thereby minimizing the effects of loading on the supply. In addition, the plus and minus floating outputs of the PS 503A can be programmed remotely, by either voltage programming or resistance programming, via the rear interface.

The PS 501-1 supplies 0 volt to 20 volt (floating) and adjustable current limiting to 400 milliamps, with constant current operation above the limit setting. A multiturn dial with mechanical digital readout provides accurate setting of the output voltage. The fixed 5 volt supply supplies up to 1 amp.

The PS 503A provides a floating dual −20 volt to 0 volt and 0 volt to +20 volt variable supply, plus the 5 volt 1 amp supply. The two variable supplies can be set individually and then varied in a tracked mode with a single control. By grounding one of the two outside terminals of the variable supply you can have a 0 volt to 40 volt supply with up to 1 amp of current when the PS 503A is operated in the high-power compartment of a TM 504, TM 506, RTM 506, or TM 5006. Full descriptions of the IEEE Standard 488 compatible PS 5004 and PS 5010 appear on pages 361 and 362.

## POWER SUPPLIES COMPARISON OF CHARACTERISTICS

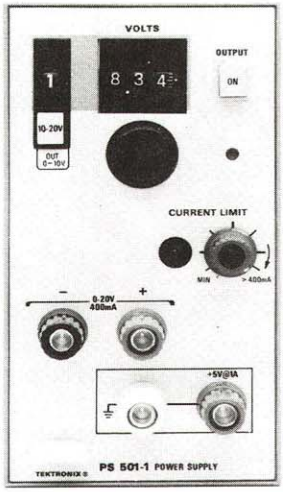
| | PS 501-1 | | PS 503A | | PS 5004 | PS 5010 | |
|---|---|---|---|---|---|---|---|
| **Power Supplies** | **0 to 20 V** | **+5 V** | **+ and −20 V** | **+5 V** | **0 to 20 V** | **+ and −32 V** | **Logic** |
| Floating | 350 V (dc + peak ac) | Ground Referenced | 350 V (dc + peak ac) | Ground Referenced | 42 V (dc + peak ac) | 150 V peak front panel, 42 V peak rear interface | Ground Referenced |
| Voltage Range | 0 to 20 V | 5 V | 0 to ±20 V | 5 V | 0 to 20 V | 0 to ±32 V | 4.5 to 5.5 V |
| Current Range<br>High Power Compartment | 40 mA to 400 mA | 1 A | 100 mA to 1 A | 1 A | 0 to 300 mA | 50 mA to 0.760 A (1.6 A up to 15 V) | 100 mA to 3.0 A |
| Standard Compartment | | | 40 mA to 400 mA | | | 50 mA to 400 mA (0.750 A up to 15 V) | |
| Voltage Mode<br>Overall Accuracy (total effect) | | | | | ±(0.01% +500 μV) | ±(0.5% +20 mA) | ±50 mV |
| Accuracy | 0.5% | | | | | | |
| Source Effect (line regulation) | 5 mV | 50 mV | 5 mV | 5 V ±0.25 V | 0.005% | ±(0.1% +2 mV) | 1 mV |
| Load Effect (load regulation) | 1 mV for a 400 mA change in load current | 100 mA for 1 A change in load current | 3 mV for 1A change in load current | 100 mV for 1 A change in load current | 500 μV for 300 mA change in load current | 10 mV for 1 A change in load current<br>1 mV using remote sensing | |
| Temperature Coefficient | Typically <0.01%/°C | | Typically <0.025%/°C | | ≤(30 ppm +100 μV/°C | Typically <(0.01% +0.1 mV)/°C | Typically <500 μV/°C |
| Resolution (step size) | 1.6 mV | | 50 mV | | 500 μV | 10 mV up to 10.0 V<br>100 mV above 10.1 V | 10 mV |
| PARD (ripple and noise)<br>(Periodic and Random Deviations) | 0.5 mV p-p<br>0.1 mV RMS | 5 mV p-p | 3 mV p-p | 5 mV p-p | ≤3 mV p-p | 10 mV p-p<br>1 mV RMS | 10 mV p-p<br>2 mV RMS |
| Current Mode<br>Overall Accuracy (total effect) | Current limit | Current limit | Current limit | Current limit | Constant current 10 mA to 300 mA | Constant current ±(5% +20 mA) | Current limit with fold back ±(5% +20 mA) |
| Source Effect (line regulation) | | | | | | 1 mA | |
| Load Effect (load regulation) | | | | | | 10 mA | |
| Temperature Coefficient | | | | | | Typically <(0.1% +1 mA)/°C | |
| Resolution (step size) | | | | | 2.5 mA | 50 mA | 100 mA |
| PARD (ripple and noise) | | | | | | 10 mA p-p 5 mA RMS | |
| Display<br>Voltage | 10 turn potentiometer with a three digit in-line dial and range pushbutton | None | Voltage indicator lights. Brightness varies with output voltage | None | Five digit LED | Each supply has three digit LED display shared between voltage and current | |
| Current | LED indicator | None | Current limit indicator lights | None | | | |
| Programmability | Voltage Programming | None | Voltage and resistance programming | None | IEEE Standard 488-1978 (GPIB) full listen and talk capability with interrupt status reporting | | |
| Tracking | None | None | Ratio | None | None | Arithmetric | None |
| Remote Sensing | Rear interconnect | | Rear interconnct | | Rear interconnect | Rear interconnect | |
| Output On/Off | Yes | | Yes | | Yes | Yes | |
| Mainframe Capability | TM 500/TM 5000 Series | | TM 500/TM 5000 Series | | TM 5000 Series | TM 5000 Series | |





For recommended accessories — refer to page 458.

PS 501-1




Power Supply

## PS 501-1

**Floating Output, 0 V to 20 V**

**0 mA to 400 mA**

**Precise Regulation**

**Low Ripple and Noise**

**Fixed Output + 5 V at 1 A**

**3 1/2 Digit Ten Turn Dial**

The PS 501-1 features precise regulation and better than 2 mV resolution (setability) over a 0 V to 20 V range.

### CHARACTERISTICS

**Output** — 0 V to 20 V dc.

**Maximum Rated Current** — 400 mA to +30°C derating to 300 mA at +50°C.

**Accuracy** — ±(0.5% + 10 mV).

**Current Limit** — <40 mA to 400 mA.

**Line Regulation** — Within 5 mV for a +10% line voltage change.

**Load Regulation** — Within 1 mV for a 400 mA load change.

**Ripple and Noise** — 0.5 mV p-p or less; 20 Hz to 5 MHz.

**Temperature Coefficient** — Typically <(0.01% +0.1 mV)/°C.

**Minimum Resolution** — Typically 1.6 mV.

**Transient Recovery Time** — ≤20 μs to recover within 20 mV of final output voltage after a 400 mA change in output current.

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**PS 501-1** Power Supply ..... **$530**

#### COMMON CHARACTERISTICS (PS 501-1, PS 503A)
#### 20 V FLOATING SUPPLIES

**Primary Power Input** — Determined by mainframe (TM 501, TM 503, etc).

**Output** — Floating, isolated for 350 V dc + peak ac above ground.

**Stability** — Typically (0.1% +5 mV) or less drift in 8 hrs of constant line, load, and temperature.

**Indicator Lights** — Voltage variation and current limit.

#### +5 V GROUND-REFERENCED SUPPLY

**Output** — 5 V nominal, ±0.25 V at 1 A.

**Load Regulation** — Within 100 mV with a 1 A load change.

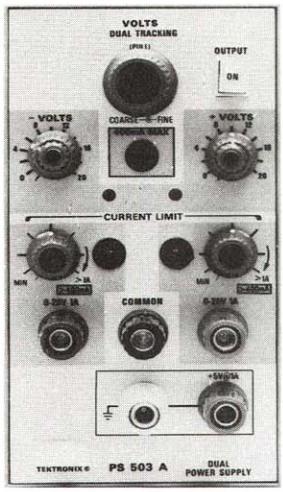
**Line Regulation** — Within 50 mV for a 10% line voltage change.

**Ripple and Noise (1A)** — 5 mV p-p or less, 20 Hz to 5 MHz.

**Stability** — Typically 30 mV or less drift in 8 hrs.

**Overload Protection** — Automatic current limiting and overtemperature shutdown.

PS 503A




Triple Power Supply

## PS 503A

**Independent + and − Controls**

**Dual Tracking Voltage Control**

**0 V to ±20 V at 1 A (in High-Power Compartment)**

**Fixed Output + 5 V at 1 A**

**Remote Resistance Programming**

**Over-Voltage Protection Standard**

The PS 503A features superior dual tracking performance, over-voltage protection, and remote resistance programming of voltage. When operated in the high-power compartment of a TM 504 or TM 506 Mainframe, the PS 503A provides up to 1 A from both 0 V to 20 V supplies.

### CHARACTERISTICS

#### ±20 V FLOATING SUPPLIES

**Outputs** — 0 V to ±20 V dc with respect to the common terminal or 0 V to 40 V dc across the + and − terminals. Outputs can be varied independently or at a constant ratio.

**Maximum Rated Current** — 400 mA (1 A in high power compartment to +30°C derating to 300 mA (750 mA) at +50°C.

**Tracking Mode Offset Error** — If the two supplies are set independently to any given voltage ratio and then varied by use of the Volts Dual Tracking control, the two supplies will maintain the same voltage ratio as initially set within ±50 mV.

**Current Limit** — Adjustable from <100 mA to 1 A (high-power compartment) or <40 mA to 400 mA (standard compartment) on each supply.

**Load Regulation** — Within 3 mV for 1 A change (high-power compartment) or 1 mV for 400 mA change (standard compartment).

**Ripple and Noise** — 3 mV p-p or less at 1 A load (high-power compartment). 0.5 mV p-p or less at 400 mA load (standard compartment).

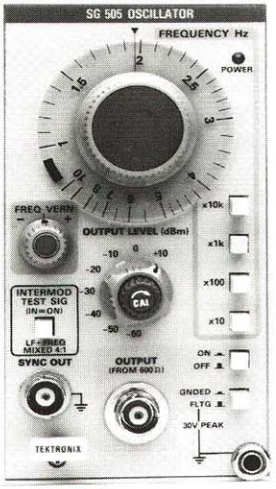
**Indicators** — Individual voltage indicators and current limiting indicators for both + and − supplies. Standard compartment (400 mA) indicator.

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

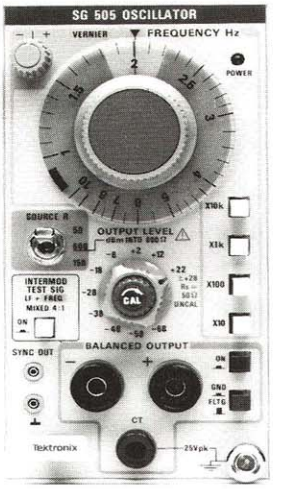
**PS 503A** Power Supply ..... **$660**

**SG 505 Option 01**




**Oscillator**

**SG 505 Option 02**




**Oscillator**

## SG 505/Option 01/Option 02

**10 Hz to 100 kHz Sinewave Output**

**Ultra-Low Distortion: <0.0008% THD (Typically 0.0003%)**

**Floating or Grounded Output**

**600 Ohm Source Impedance**

**Vernier Frequency Control**

**Fully Balanced Output (Option 02)**

**Calibrated Output to +28 dBm (Option 02)**

**Selectable Source Impedance (Option 02)**

**Intermodulation Test Signal (Option 01 & 02)**

The SG 505 Oscillator generates an ultra-low distortion sinewave over the frequency range from 10 Hz to 100 kHz (<0.0008% THD, typically 0.0003% between 20 Hz and 20 kHz). In the standard and Option 01 units the output can be floated or referenced to chassis ground. In the Option 02 unit, the output is fully balanced and floating with a center tap which may be attached to system ground or to either side of the output signal. The oscillator also provides a fixed amplitude ground referenced sinewave at the Sync Out connector, which is identical in frequency to the signal from the Output connector.

Option 01 adds an intermodulation test signal function. This signal consists of a selectable 60 Hz or 250 Hz mixed with the selected frequency in a 4:1 amplitude ratio.

For communications and broadcast applications, the Option 02 provides a fully balanced output of +28 dBm into 600 ohms from 50 ohms. A ten-position step attenuator (10 dB per step) and a variable attenuator provide continuous attenuation of signal amplitude to below −78 dBm into 600 ohms.

A front panel switch allows the selection of three different source resistances: 50 ohms for low impedance applications (improves measurement accuracies on long cable runs and reduces loading effects), 150 ohms for matching microphone circuits, and 600 ohms for complying with audio/communication industry standard and general purpose applications.

Option 02 also includes the intermodulation test signal capability of the Option 01.

### CHARACTERISTICS (Std and Opt 01)

#### MAIN OUTPUT

**Frequency Range** — 10 Hz to 100 kHz in four overlapping bands. Accurate within 3% of dual setting (with Vernier at center). Vernier Range is at least ±1% of frequency setting.

**Calibrated Output** — Selectable from +10 dBm to −60 dBm into 600 Ω in eight 10 dB steps. Accurate to within 0.2 dB at +10 dBm and 1 kHz. Step accuracy is ±0.1 dB/10 dB step. An uncalibrated control provides continuous variation from at least +2.2 dB to <−10 dB from calibrated positon.

**Amplitude Response** — Level flatness ±0.1 dB from 10 Hz to 20 kHz (1 kHz ref); within 0.2 dB from 20 kHz to 100 kHz (excluding >50 kHz on −60 dB output level range).

**Harmonic Distortion** — <0.0008% (−102 dB) THD from 20 Hz to 20 kHz (typically 0.0003%); 0.0018% (−95 dB) THD from 10 Hz to 20 Hz, and from 20 kHz to 50 kHz; 0.0032% (−90 dB) THD from 50 kHz to 100 kHz ($R_L$ ⩾600 Ω).

**Output Impedance** — 600 Ω ±2%; floating or grounded through ≈30 Ω. Output impedance does not change with Output On/Off selection. Maximum floating voltage ±30 V peak.

**Maximum Output Voltage** — At least 6 V RMS open circuit; 3.16 V RMS (+10 dBV or +12.2 dBm) into 600 Ω.

#### SYNC OUTPUT

**Signal** — 200 mV RMS ±20% sinewave to 20 kHz, at least 120 mV RMS at 100 kHz.

**Frequency** — Same as main output.

**Impedance** — Nominally 1 kΩ, ground referenced and isolated from main output.

#### REAR INTERFACE SIGNALS

**Buffered Main Output** — Buffered version of actual output signals from front panel connector. ≈300 Ω Output impedance.

**Sync Output** — Same as front panel Sync Output except output impedance is ≈50 Ω.

#### OPTION 01 IM TEST SIGNAL

Selecting the IM Test Signal causes a LF sinewave to be mixed with the normal oscillator signal in a 4:1 amplitude ratio.

**LF Frequency** — Internally selectable 60 Hz (±1 Hz) or 250 Hz (±3 Hz).

**Main Output** — Composite p-p output within 0.2 dB of normal oscillator mode output.

**Residual IMD** — Typically <0.0005% from 2.5 kHz to 10 kHz.

**Sync Output** — LF signal component only, 200 mV RMS ±20%.

### CHARACTERISTICS (Opt 02)

#### MAIN OUTPUT

**Calibrated Output** — Selectable from +22 dBm to −68 dBm into 600 Ω in ten 10 dB steps. Accurate to within 0.2 dB at +22 dBm and 1 kHz. Step accuracy is ±0.1 dB/10 dB step or 20 dB step change. An uncalibrated control provides continuous variation from <−10 dB to +0.3 dB from calibrated position.

**Harmonic Distortion** — <0.0008% (−102 dB) THD from 20 Hz to 20 kHz (typically 0.0003%); 0.0018% (−95 dB) THD from 10 Hz to 20 Hz, and from 20 kHz to 50 kHz; 0.0056% (−85 dB) THD from 50 kHz to 100 kHz ($R_L$ ⩾600 Ω).

**Output Impedance** — Selectable 600 Ω ±2%, 150 Ω ±2% or 50 Ω ±3% floating or grounded through ≈30 Ω. Output impedance does not change with Output On/Off selection. Impedance to CT is ½ the selected impedance. Maximum floating voltage ±25 V peak.

**Maximum Output Voltage** — At least 21 V RMS open circuit; 19.45 V RMS (+28 dBm) into 600 Ω from 50 Ω.

**Balance** — ⩽0.5% mismatch of output open-circuit voltages referenced to CT for f ⩽20 kHz with output grounded.

#### INCLUDED ACCESSORIES

Cable assembly for sync output (175-1178-00); instruction manual.

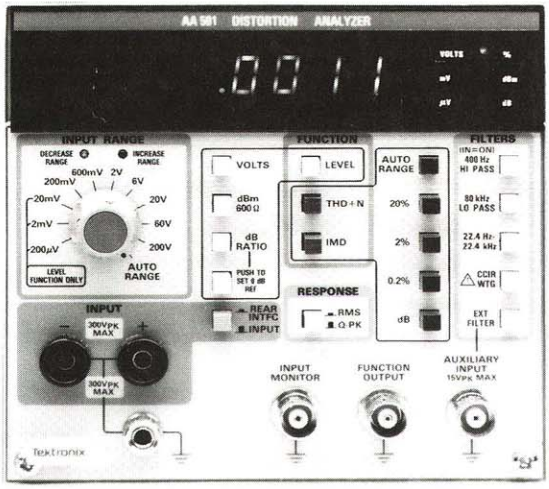
### ORDERING INFORMATION

**SG 505** Oscillator ..... **$785**

**Option 01** — IM Test Signal ..... **+$220**

**Option 02** — Oscillator (Includes Option 01) ..... **+$715**

**AA 501 Option 02**




**Distortion Analyzer**

# AA 501

**Fully Automatic: No Level Setting, Tuning or Nulling**

**Level, Total Harmonic Distortion, and dB Ratio Measurements**

**Total System Harmonic Distortion Plus Noise (THD+N) <0.0025%**

**≤3.0 μV Residual Noise**

**Digital Readout Plus Analog-Like "Bar Graph" for Peaking and Nulling**

**IMD to SMPTE, DIN, and CCIF (Option 01)**

The AA 501 Distortion Analyzer provides completely automatic measurement of level, total harmonic distortion plus noise (THD+N), and (with Option 01) Intermodulation Distortion. Automatic set level, automatic tuning, automatic nulling of the fundamental, and autoranging of the display all combine to permit completely hands-off operation once the mode is selected. Just apply the signal of interest and read the 3½-digit display. A novel analog-like bar graph simulates an analog meter to assist in peaking and nulling of applied signals.

With Option 01, intermodulation distortion measurements can be made to any of the three common standards: SMPTE, DIN, or CCIF. Internal circuitry automatically identifies the signal being used and selects the proper filtering circuits to perform the measurement.

DB ratio measurements may be referenced either to 774.6 millivolts (1 milliwatt in 600 ohms) or to a selected applied signal. The 0 dB reference memory remembers the selected level, and all subsequent measurements are referenced to that level.

The AA 501 allows readings to be expressed in true RMS or average response, RMS calibrated. Although true RMS is more accurate in most applications, the average response permits comparisons with measurements previously taken with older instrumentation.

The fundamental frequency range is 10 Hz to 100 kHz, with harmonics measured out to 300 kHz.

Any one of four built-in frequency-weighting filters may be switched into the signal paths for preconditioning of the signal to be measured. Provision is also made to permit the use of a user-selected filter as well.

A dc level, which is a function of the display readout, is available at the rear panel of the AA 501.

An Input Monitor connector and a Function Output connector are provided to permit oscilloscope display of the input signal or the result of the filter in the THD+N measurement.

The Option 02 version of the AA 501 is especially designed for use in accordance with CCIR recommendation 468-2 and DIN 45405 (typically used in Europe). In the Option 02 version, the 30 kHz filter and the "A" weighting filter of the standard unit are replaced by a 22.4-Hz-to-22.4-kHz filter and a CCIR-weighting filter, respectively, and the average responding detection circuit is replaced by a quasi-peak detection circuit. The Option 02 also contains the intermod measurement capability of the Option 01.

The AA 501 Distortion Analyzer and the SG 505 Oscillator were designed to be used together as the heart of a state-of-the art audio analysis system. Used together, the two provide total system harmonic distortion of 0.0025% or less.

It should be noted that the automatic frequency tuning of the AA 501 does not depend upon the manual tuning of a companion oscillator. The AA 501 will automatically tune itself to its input signal whether the signal originates from an SG 505 alongside it in a TM 500 mainframe, or from some other signal source miles away.

## CHARACTERISTICS

The following electrical characteristics are common to the standard AA 501, Option 01 and Option 02 unless otherwise noted:

### THD

Complete automatic Total Harmonic Distortion (THD) measurements to specified accuracy in 7 s or less.

### LEVEL

Autoranging digital voltmeter displays input signal level in volts, dBm, or dB ratios.

### IMD (OPTION 01, OPTION 02)

Fully automatic SMPTE, DIN, and CCIF difference frequency test measurements.

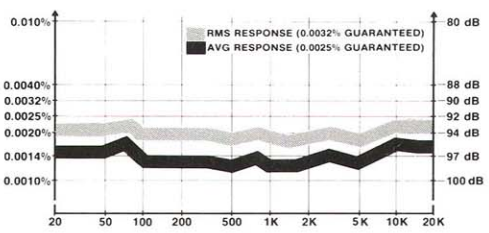
### NOISE (OPTION 02)

Noise measurements to CCIR recommendation 468-2 and DIN 45405. True RMS or quasi-peak response. Total system THD+N = 0.0032% (90 dB) RMS response. Balanced input.

### DISTORTION FUNCTION

**Fundamental Frequency Range** — 10 Hz to 100 kHz automatically tuned to input frequency.
**Distortion Ranges** — Auto (100%), 20%, 2%, 0.2%, and dB (autoranging).
**Accuracy (Readings ≥4% of Range)** — 20 Hz to 20 kHz ±1 dB, 10 Hz to 100 kHz +1, −3 dB. (Accuracy is limited by residual THD+N and filter selection.)
**AA 501/SG 505 System Residual THD+N** — $V_{in}$ ≥250 mV, (all distortion, noise, and nulling error sources combined).
20 Hz to 20 kHz:
≤0.0025% (−92 dB) Average Response with 80 kHz filter (standard and Option 01 only).
≤0.0032% (−90 dB) RMS Response with 80 kHz filter.
10 Hz to 50 kHz:
≤0.0071% (−83 dB) RMS Response.
50 kHz to 100 kHz:
≤0.010% (−80 dB) RMS Response.

### TYPICAL THD+N




**Typical Fundamental Rejection** — At least 10 dB below specified residual THD+N or actual signal THD, whichever is greater.
**Minimum Input Level** — 60 mV (−22 dBm).

### LEVEL FUNCTION

**Modes** — Volts, dBm (600 Ω), or dB ratio with push to set 0 dB reference.
**Level Ranges** — 200 μV full scale to 200 V full scale in ten steps, manual or autoranging.
**Accuracy**[*1]

| Frequency | Volts | dBm or dB Ratio |
|---|---|---|
| 20 Hz to 20 kHz | ±2% | ±0.3 dB |
| 10 Hz to 100 kHz[*2] | ±4% | ±0.5 dB |

*[*1] $V_{in}$ ≥ 100 μV, level ranging indicators extinguished.*
*[*2] On the 200 μV range, accuracy above 50 kHz is +4%, −6% (+0.5 dB, −0.7 dB).*

**Bandwidth** — ≥300 kHz.
**Residual Noise** — ≤3.0 μV (−108 dBm) with 80 kHz and 400 Hz filters. ≤1.5 μV (−114 dBm) with "A" weighting filter.

### INTERMODULATION DISTORTION FUNCTION (OPT 01/02)

**SMPTE and DIN Tests**
Lower Frequency Range: 50 Hz to 250 Hz.
Upper Frequency Range: 3 kHz to 100 kHz.
Level Ratio Range: 1:1 to 5:1 (lower:upper).
Residual IMD: ≤0.0025% (−92 dB) for 60 Hz and 7 kHz or 250 Hz and 8 kHz, 4:1 level ratio.
**CCIF Difference Frequency**
Frequency Range: 4 kHz to 100 kHz.
Difference Frequency Range: 50 Hz to 1 kHz.
Residual IMD: ≤0.0018% (−95 dB) with 14 kHz and 15 kHz.
Minimum Input Level: 60 mV (−22 dBm).
**Accuracy** — ±1 dB.

### ALL FUNCTIONS

**Filters**
400 Hz High Pass: −3 dB at 400 Hz ±5%; at least −40 dB rejection at 60 Hz.
80 kHz Low Pass: −3 dB at 80 kHz ±5%.
30 kHz Low Pass: −3 dB at 30 kHz ±5% (standard and Option 01 only).
"A" Weighting: Meets specifications for Type 1 sound level meters (ANSI S 1.4, IEC Recommendation 179) (standard and Option 01 only).
Ext: Allows connection of external filters.
22.4 Hz to 22.4 kHz: −3 dB ±5% (Option 02 only).
CCIR WTG: CCIR Recommendation 468-2 and DIN 45405, functional only with Q-PK detector (Option 02 only).
**Input Impedance** — 100 kΩ ±2%, each side to ground, fully differential.
**Maximum Input** — 300 V peak, 200 V RMS either side to ground or differentially. Fully protected on all ranges.
**Common Mode Rejection** — ≥50 dB at 50 Hz or 60 Hz. Typically ≥40 dB to 300 kHz.
**Detection** — Average or true RMS for waveforms with crest factors ≤3.

### FRONT PANEL SIGNALS

**Input Monitor** — Provides constant amplitude version of signal applied to input. Output Voltage: 1 V RMS ±10% for input signals >50 mV. Source Impedance: 1 kΩ ±5%.
**Function Output** — Provides a scaled sample of selected function signal (1000 count display = 1 V RMS ±3%). Source Impedance: 1 kΩ ±5%.
**Auxiliary Input** — Provides input to detector circuit when Ext Filter button is depressed. Sensitivity: 1 V RMS ±3% = 1000 count display. Impedance: 100 kΩ ±5%, ac coupled.

### REAR INTERFACE SIGNALS

**Rear INTFC Input** — Front panel selected. Same as main Input except, maximum signal input is limited to 42 V peak, 30 V RMS. (Potential crosstalk at rear interface may degrade noise and distortion on performance).
**Monitor** — Same as front panel Input Monitor.
**Function Output** — Same as front panel Function Output.
**Auxiliary Input** — Same as front panel Auxiliary Input.
**Converter Output** — Dc output of selected response converter. 1 V ±5% for 1000 count display. Source Z: 500 Ω ±5%.
**dB Output** — Dc output of logarithmic dB converter. 10 mV ±5% per 1 dB of display. Source Z: 1 kΩ ±5%.
**Included Accessory** — Instruction manual.

## ORDERING INFORMATION

**AA 501** Distortion Analyzer ..... **$2,330**
**Option 01** — Intermodulation Distortion ..... **+$750**
**Option 02** — CCIR/DIN (Includes Option 01) ..... **+$1,150**

## PRODUCT SUMMARY

The TM 500 Signal Conditioners offer unique capabilities for solving electrical measurement and analysis problems. Compact portability and plug-in flexibility allow complete lab instrumentation set-ups, within stringent space and budget limitations.

These versatile signal alteration devices are applicable to a broad range of measurement needs including: preamplification of low level signals, addition or removal of dc offset, integration, differentiation, or summing of multiple signals; impedance transformation; or amplification (to 80 V peak-to-peak).

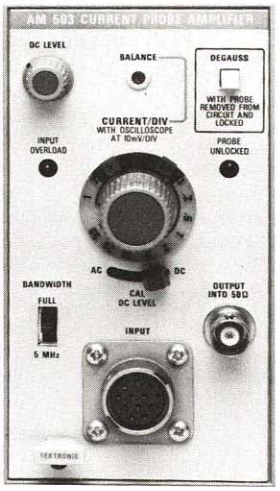
The AM 503 is specifically designed to work with the A6303/A6302 Current Probes (dc to 50 MHz), and incorporates a feature that limits the bandwidth to 5 MHz, to eliminate transients or noise. An illuminated knob skirt indicates calibrated current per division.

The A6302/AM 503 and A6303/AM 503 Current Probe Systems have a wide variety of applications from SCR and power supply measurements to medical applications. These probes use inductive coupling to minimize interference with the circuit under test.

The versatile AM 502 Differential Amplifier lets you control gain, dc offset and low-frequency and high-frequency response for maximum rejection of unwanted signals. Adjustable dc offset allows high amplification even when low-level signals have a dc component of up to 1 V. High performance features of the AM 502 are a dc to 1 MHz bandwidth and 100 dB common-mode rejection ratio.

The AM 501 Operational Amplifier's output power (±40 V and ±50 mA across 800 Ω loads) is more than adequate for most electronic and electro-mechanical applications. This high-output unit has front panel connectors that let you change configurations by selecting feedback components. The AM 501 is easily set up for differentation, integration, summing and impedance transformation problems.

**AM 503**




**Current Probe Amplifier**

## AM 503

**Displays Current Signals on an Oscilloscope**

**Current Range, Maximum Current, and Bandwidth Determined by the Probe Used**

The AM 503 Current Probe Amplifier allows display of current on any oscilloscope with 10 mV/div sensitivity, 50 Ω or 1 MΩ input, and (for performance to full bandwidth specifications) at least 75 MHz when using the A6302 or 50 MHz when using the A6303. The amplifier attenuator is calibrated in 12 steps with a 1-2-5 sequence, and the knob-skirt is illuminated to indicate current per division. The current range, maximum current rating, and bandwidth are determined by the particular probe in use. Bandwidth can be set to Full (where it is limited by the probe in use) or to 5 MHz. Coupling may be switch selected to ac or dc. Ac coupling offers a convenient means of measuring low-amplitude ac signals on a high-level dc current. A front-panel indicator warns of input current overload.

### CHARACTERISTICS

The AM 503 characteristics when used with the A6302 or A6303 Current Probes.

**Maximum Input Current** — 20 A (dc + peak ac) for A6302. 100 A (dc + peak ac) for A6303.

**Maximum Voltage for Current Under Test (Bare Conductor)** — 500 V (dc + peak ac) for A6302. 700 V (dc + peak ac) for A6303.

**Bandwidth (−3 dB)** — Dc to at least 50 MHz with A6302. Dc to at least 15 MHz with A6303.

**Risetime (Full Bandwidth)** — 7 ns or less with A6302. 23 ns or less with A6303.

**Deflection Factor** — 1 mA/div to 5 A/div for A6302. 20 mA/div to 50 A/div for A6303. In a 1-2-5 sequence for both probes.

**Attenuator Accuracy** — Within 3% of indicated Current/Div for both probes.

**INCLUDED ACCESSORIES**

50 Ω cable with BNC (012-0057-01); 50 Ω terminator (011-0049-01); instruction manual.

**ORDERING INFORMATION**

**AM 503** Current Probe Amplifier ..... **$1,115**

## A6303 Current Probe

**Ac and Dc Current Measurements to 100 A**

**Dc to 15 MHz Bandwidth**

**Peak Pulse Measurements to 500 A**

**Ac or Dc Coupling**

**One Inch by 0.830 Inch Jaw Opening**

**One-Hand Operation**

This clamp-around probe satisfies requirements for current measurements to 100 A from dc to 15 MHz. Equipped with a convenient pistol grip, the A6303 can easily be clamped to cables up to 0.830 inch. Other measurement parameters of the probe include: 100 A continuous and 500 A peak.

By combining an oscilloscope, like the SC 504, with the A6303/AM 503 Current Probe Amplifier in a TM 500/TM 5000 mainframe you will have a convenient and compact high current amplification/-measurement system.

**INCLUDED ACCESSORIES**

Carrying case (016-0622-00); instruction manual.

**ORDERING INFORMATION**

**A6303** Current Probe ..... **$1,060**

## A6302 Current Probe

**1 mA to 20 A Current Measurement Range**

**50 A Peak Pulse Measurements**

**Dc to 50 MHz Bandwidth**

When a A6302 Current Probe is used with the AM 503 Current Probe Amplifier, the current range is from 1 mA to 20 A. Maximum current is 20 A (dc + peak ac). Peak pulse maximum is 50 A, not to exceed a product of 100 A μs. The probe operates through inductive coupling with no electrical contact. A flick of your forefinger operates the sliding jaw in the insulated probe tip. Just put the probe tip around the conductor under test for immediate current readings.

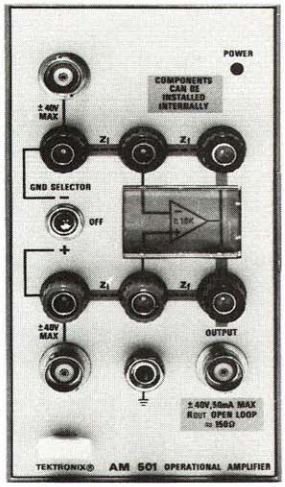
**INCLUDED ACCESSORIES**

Five inch ground lead (175-0124-01); three inch ground lead (175-0263-01); two alligator clips (344-0046-00); instruction manual.

**ORDERING INFORMATION**

**A6302** Current Probe ..... **$560**

**AM 501**




**Operational Amplifier**

## AM 501

**±40 V, 50 mA Output**

**Open Loop Gain 10,000**

**50 V/μs Slew Rate**

**Symmetrical Differential Design**

The AM 501 Operational Amplifier features high input impedance (FET), high slew rate, a wide range of input and output voltage, and high output current. Applications include: amplification; impedance transformation; integration; differentiation and summing. It is well-suited as a post-amplifier or offset-generator for signal sources, including the TM 500 modules. Components may be added externally or internally making it ideal for teaching operational amplifier theory.

### CHARACTERISTICS

#### OPERATIONAL AMPLIFIER

**Open Loop Gain** — At least 10,000 at 60 Hz into 800 Ω load.

**Unity Gain Bandwidth** — At least 5 MHz into 800 Ω load.

**Common-Mode Rejection Ratio** — Typically >20,000 to 1 at 60 Hz for common-mode signals up to ±40 V.

**Slew Rate** — At least 50 V/μs into an 800 Ω load.

#### INPUT

**Input Bias Current** — Typically <500 pA at 25°C, <2 nA at 50°C.

**Drift** — <100 μV/°C.

**Noise** — <10 μV RMS.

**Maximum Differential Input Voltage** — 80 V.

#### OUTPUT

**Voltage Range** — At least ±40 V into 2 kΩ.

**Current Limit** — At least ±50 mA.

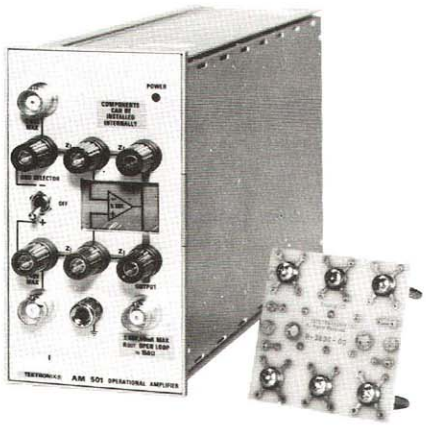
**Open Loop Output R** — ≈150 Ω.

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**AM 501** Operational Amplifier ..... **$630**

**AM 501 Accessory**



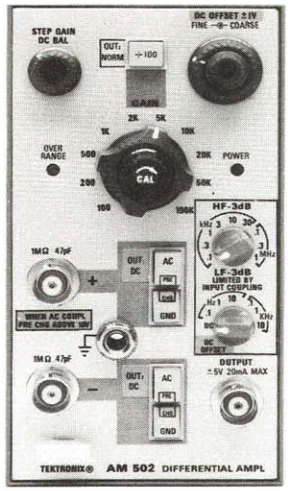
**AM 501 Auxiliary Circuit Board Kit**

The AM 501 Auxiliary Circuit Board Kit attaches to the input and output terminal plugs on the front of the AM 501 Operational Amplifier. The kit is a pc board that has six terminal studs for attachment to the amplifier's banana jacks and is approximately 2.5 inches square. This permits the designer to build a circuit of resistors, capacitors, and other components for use in conjunction with the AM 501's input, output, or feedback circuits. With several boards, the AM 501 Op Amp circuit can be changed instantly in configuration from integrator to differentiator to amplifier and does not interfere with the other connectors on the face of the AM 501.

### ORDERING INFORMATION

**AM 501** Auxiliary Circuit Board Kit
Order 013-0146-00 ..... **$22**

**AM 502**




**Differential Amplifier**

## AM 502

**1 to 100,000 Gain**

**100 dB CMRR**

**Selectable Upper and Lower −3 dB Points**

**Dc to 1 MHz Maximum Bandwith**

**Adjustable Dc Offset**

The AM 502 Differential Amplifier features wide bandwidth, high CMRR, and selectable calibrated gain and filtering. Well-suited for general purpose or laboratory work, it can drive oscilloscopes, monitors, chart recorders, displays, or processing devices. In the unity gain mode, it can be used as a signal conditioner. Input dc offsetting to ±1 V is provided.

### CHARACTERISTICS

#### AMPLIFIER

**Gain** — 100 to 100,000; 1-2-5 sequence; accurate within 2%. 1X gain obtained by 100X attenuation.

**HF −3 dB POINT** — Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz. Upper −3 dB point reduces to 500 kHz at 50 k gain; 250 kHz at 100 k gain.

**LF −3 dB POINT** — Selectable in 6 steps from 0.1 Hz to 10 kHz; ac coupling limits −3 dB point to 2 Hz or less.

**Variable Dc Offset** — At least ±1 V.

**Common-Mode Rejection Ratio** — Normal Mode: At least 100 dB, dc to 50 kHz. ÷ 100 Mode: At least 50 dB, dc to 50 kHz.

**Maximum Input Voltage** — Normal Mode Dc Coupled: 15 V (dc + peak ac). ÷ 100 Mode Dc Coupled: 350 V (dc + peak ac). Ac Coupled: 350 V (dc + peak ac) with coupling capacitor precharged.

**Input R and C** — 1 MΩ paralleled by ≈47 pF. Input impedance can be increased to a FET input via a simple internal jumper change.

**Maximum Voltage Drift** — 100 μV/°C referred to input Normal mode.

**Input Gate Current** — ±100 pA for T ≤30°C.

**Maximum Noise** — ≤25 μV or less (tangentially measured) referred to input Normal mode.

#### OUTPUT

**Maximum Output** — ±5 V, ±20 mA, output resistance is 5 Ω or less.

**Minimum Load Impedance** — 250 Ω

**Over Range** — Front-panel lamp indicates most over-range conditions.

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**AM 502** Differential Amplifier ..... **$1,260**

For compatible accessories — refer to page 436.

## PRODUCT SUMMARY

The ubiquitous cathode-ray oscilloscope is the world's most useful and versatile electronics test and measurement instrument. Tektronix, long identified with the oscilloscope, could hardly develop the TM 500 line of modular instrumentation without including CRT display capability.

Four choices of performance level and display size are available to add waveform display to the digital measurement capability of the TM 500 digital multimeters and counters, ranging from the high-performance, dual-trace, 80 MHz SC 504 to the single-trace, single-width, 5 MHz SC 501. The 15 MHz SC 502 adds moderate dual-trace performance to the line, and the 10 MHz, dual-trace SC 503 adds CRT storage capability.

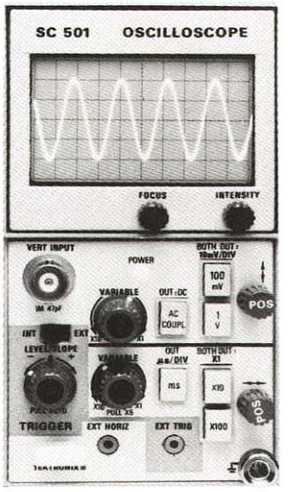
All of the oscilloscopes feature automatic triggering, and the SC 504, SC 503, and SC 502 also provide trigger view and variable trigger holdoff. All of the oscilloscopes have provisions to permit instrument-to-instrument rear interfacing within a mainframe and to external devices of a test system.

With a compact TM 500 oscilloscope and a multicompartment TM 500 mainframe, it is now possible to carry an oscilloscope and companion instruments to and from a test site in one convenient package.

**TM 500 OSCILLOSCOPE SELECTION GUIDE**

| | SC 504 | SC 503 | SC 502 | SC 501 |
|---|---|---|---|---|
| Number of Channels | 2 | 2 | 2 | 1 |
| Bandwidth (MHz) | 80 | 10 | 15 | 5 |
| Highest Sensitivity (mV/Div) | 5 | 1 | 1 | 10 |
| Fastest Sweep Rate (ns/Div) | 5 | 50 | 20 | 200 |
| Storage | No | Yes | No | No |

**SC 501**




**5 MHz Oscilloscope**

# SC 501

**5 MHz Bandwidth**

**Single Compartment Size**

**6.4 cm (2.5 in) CRT**

**Versatile Operating Features**

The SC 501 is a single-channel, 5 MHz plug-in unit oscilloscope with a 2.5 inch CRT display that occupies a single TM 500 Series plug-in compartment. Oscilloscope capability significantly enhances the application range of the multifunctional TM 500 Series test and measurement instruments.

With the SC 501 a multitude of versatile test systems may be structured from the TM 500 Series to suit specific needs for time and frequency response, modulating waveforms, power for devices under test, stimulus and response studies and voltage, current, and temperature measurements. Since the SC 501 fits any TM 500 or TM 5000 mainframe, it can be used on the bench, in a rack, or on the road. The single-channel SC 501 has a calibrated vertical deflection range from 10 mV/div to 1 V/div, selectable in decade steps. A variable control extends this range to at least 10 V/div.

Calibrated sweep rates are selected by push-button logic in decade steps from 1 μs/div to 100 ms/div. A variable control extends the slowest sweep rate to at least 1 s/div and a fixed magnifier extends the fastest sweep rate to 200 ns/div.

A 0 V to 10 V ramp for all sweep rates (excluding the X5 magnification) is provided at a rear interface connector. This capability may be used for many auxiliary functions, for example sweeping a voltage-controlled frequency oscillator.

The triggering circuits allow stable triggering from either internal or external sources. An Autotriggering mode and manual Level/Slope selection is combined in a single control. It is useful above 10 Hz and provides a bright baseline at all sweep rates.

For X-Y operation an internal switch converts the horizontal deflection system of the SC 501 to an external horizontal amplifier which is internally calibrated for 100 mV/div deflection factor with a bandwidth of 100 kHz.

## CHARACTERISTICS

### VERTICAL DEFLECTION

**Bandwidth** — Dc to >5 MHz.

**Deflection Factors** — 10 mV/div, 100 mV/div, and 1 V/div. Accuracy, within 3%. Uncalibrated (variable) range, continuously variable between steps (10:1) and to at least 10 V/div.

**Input Coupling** — Ac or dc.

**Input Impedance** — 1 MΩ paralleled by 47 pF.

**Maximum Input Voltage** — 350 V (dc + peak ac).

### HORIZONTAL DEFLECTION

**Time Base** — Calibrated Sweep Rates: 1 μs/div to 100 ms/div in decade steps. Uncalibrated (Variable) Range: Extends slowest calibrated rate to ≥1 s/div. X5 Magnifier (Fixed): Extends fastest calibrated sweep rate to 200 ns/div. Accuracy (Over Center 8 Div): ≤5% for all sweep rates. Linearity (Any Two Div Portion Within Center Eight Div): ≤5%.

**External Horizontal Amplifier** — Bandwidth: Dc to 100 kHz. Input Impedance: ≥100 kΩ paralleled by 25 pF. Maximum Input Voltage: ±3 V.

### TRIGGER

**Normal Trigger Sensitivity (Trigger Level/Slope In)** — Internal: Dc coupled, 0.4 major div of deflection at dc; increasing to 1.0 major div of deflection at 5 MHz. External: Dc coupled, 1 V minimum to 5 V maximum from dc to 5 MHz. External Trigger Input Impedance: 22 kΩ paralleled by ≈150 pF.

**Auto (Trigger Level/Slope Out)** — Sweep free-runs without trigger signal, or for trigger repetition rates below 10 Hz.

### CRT

**Phosphor** — GH (P31) is standard.

**Graticule** — 6 x 10 div (0.203 in/div).

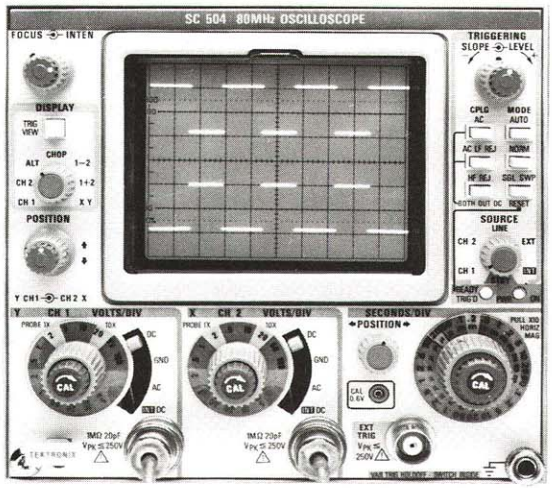
**Included Accessory** — Instruction manual.

## ORDERING INFORMATION

**SC 501** 5 MHz Oscilloscope ..... **$1,360**

Compatible accessories begin on page 436.

## SC 504




**80 MHz Oscilloscope**

# SC 504

**80 MHz Bandwidth**

**5 mV/div Maximum Sensitivity**

**5 ns/div Maximum Calibrated Sweep Rate**

**Enhanced Automatic Triggering**

**True X-Y Capability**

**Switchable Rear Interface Capability**

The SC 504 is a general purpose, dual-trace, non-delayed-sweep oscilloscope. It has a high writing speed with a maximum sensitivity of 5 mV/div, and a maximum sweep rate of 5 ns/div (with magnifier). This oscilloscope features Add (CH 1 plus CH 2), differential (CH 1 minus CH 2), and "true" X-Y modes, and also includes rear interfacing capability (switchable CH 1, CH 2 and ext trig inputs). Enhanced autotriggering, trigger view, and variable trigger holdoff make this oscilloscope very versatile and easy to use. The Tektronix P6108, P6122 and P6062B probes are recommended for use with the SC 504.

## CHARACTERISTICS

### VERTICAL DEFLECTION

**Bandwidth at −3 dB Points** — Dc to at least 80 MHz from 0°C to +35°C; dc to at least 70 MHz from +35°C to +50°C.

**Risetime** — 4.4 ns or less from 0°C to +35°C; 5 ns or less from +35°C to +50°C.

**Ac Low Frequency Response (Lower −3 dB Points)** — Without probe, 10 Hz; with 10X probe, 1 Hz.

**Deflection Factors** — Calibrated Range: 5 mV to 10 V/div, 11 steps in a 1-2-5 sequence.

**Accuracy** — ±2%, +15°C to +35°C; ±3%, 0°C to +50°C. Uncalibrated Range: Continuously variable between calibrated steps. At least 2.5:1 range. Extends maximum deflection factors to at least 25 V/div.

**Modes** — CH 1, CH 2, Alt., Chop, CH 1 minus CH 2, CH 1 plus CH 2, X-Y. Chop rate at least 250 kHz.

**Input R and C** — 1 MΩ ±1% paralleled by ≈20 pF.

**Maximum Input Voltage** — 250 V (dc + peak ac), 500 V p-p ac at 1 kHz or less.

**Common-Mode Rejection Ratios** — At least 50:1 up to 1 MHz, and 10:1 from 1 MHz to 10 MHz when using the same attenuator settings; common-mode signal 5 div or less.

**Position Range** — ±6 div.

**Delay Line** — Permits viewing leading edge of displayed waveform.

**Calibrator** — 0.6 V, ±1%, ≈1 kHz frequency.

### HORIZONTAL DEFLECTION

**Sweep Generator** — Calibrated Sweep Rates: 0.2 s to 50 ns/div, 21 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates of 5 ns/div. Uncalibrated (Variable) Range: The Cal (variable) control provides sweep rates that are continuously variable between the calibrated rates, and extends the slowest sweep rate to at least 0.5 s/div.

**Sweep Rate Accuracy** — Measured over center 8 divisions, excluding first 50 ns and all after the first 100 divisions of magnified sweep. Derate accuracies by an additional 1% from 0°C to +15°C, and +35°C to +50°C.

| +15°C to +35°C | X1 | X10 |
|---|---|---|
| 20 ms/div to 0.2 μs/div | ±2% | ±3% |
| 0.2 s/div to 50 ms/div | ±3% | ±4% |
| 0.1 μs/div to 50 ns/div | ±3% | ±4% |

**X-Y Mode** — Bandwidth: Dc to at least 2 MHz. Deflection factor, selected by CH 2 controls and horizontal mag X1, X10 with 5% accuracy. X and Y amplifier phase difference, less than 3° at 50 kHz or less. Input parameters same as CH 2.

### TRIGGER

**Trigger Modes** — Auto, Norm, and Sgl Swp.

**Enhanced Auto Trigger** — The trigger circuit automatically adjusts to spread the p-p signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

**Trigger Sources** — CH 1, CH 2, Line, Ext, Int.

**Trigger Coupling** — Ac, ac LF Rej, ac HF Rej, dc.

**Trigger Sensitivity** — Minimum p-p signal required.

| Coupling | Source | Dc to 30 MHz | 30 MHz to 80 MHz |
|---|---|---|---|
| Dc | CH 1, CH 2<br>External<br>Interface | 0.4 div 60 mV<br>Typically<br>50 mV | 1.0 div 150 mV<br>Typically 100 mV<br>to 50 MHz |
| Ac | Requirements increase below ≈50 kHz | | |
| Ac LF Rej | Requirements increase below ≈10 kHz | | |
| HF Rej | Requirements increase above ≈50 kHz | | |

**External Triggering Level Range** — ⩾ ±1.4 V.

**External Triggering Input** — Input R and C: 1 MΩ ±10% paralleled by approximately 24 pF. Maximum Input Voltage: 250 V (dc + peak ac); 250 V p-p at 1 kHz or less.

**Auto Mode** — Sweep free runs in the absence of a triggering signal. Trigger Level range is reduced to approximately the p-p range of the triggering signal.

**Single Sweep** — Triggering requirements are as for normal sweep. When triggered, sweep generator produces one sweep only.

**Trigger Holdoff** — At least 20 to 1 range. The variable control is internally selectable between the Variable Sweep or Variable Holdoff functions.

### CRT

**Phosphor** — GH (P31) is standard.

**Acceleration Potential** — ≈12 kV.

**Graticule** — Scale, 8 x 10 div with 0.25 in/div internal graticule lines.

### REAR INTERFACE

**CH 1 and CH 2 Vertical Inputs** — Selected by CH 1 and CH 2 coupling in Int (interface) position. Input Impedance: 50 Ω. Can be customer-modified for input impedance of 1 MΩ paralleled by ≈60 pF.

**Trigger Input** — Selected by Trigger Source switch in Int (interface) position. Input Impedance: 50 Ω when selected, 25 Ω when not selected. Can be customer-modified for input impedance of 1 MΩ paralleled by ≈40 pF.

**Z-Axis Input** — Input Impedance: ≈1.5 kΩ. +5 V turns beam On from Off condition, −5 V turns beam Off from On condition.

**Channel 1 Output** — At least 50 mV/div. Bandwidth: At least 30 MHz. Output Impedance: <50 Ω.

**Ramp Output** — 0 V to +10 V ramp. Output resistance ≈500 Ω.

**Included Accessory** — Instruction manual.

## ORDERING INFORMATION

**SC 504** 80 MHz Oscilloscope ..... **$3,395**

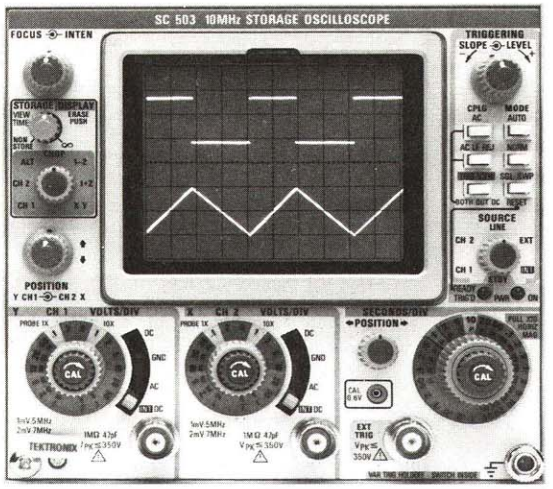
For Floating Measurements, order A6902A Isolator.
See page 434 for complete description.

### RECOMMENDED PROBES

P6122 10X, P6101 1X, P6108 10X, P6062B 1X/10X. See pages 451, 450 and 454.

Compatible accessories begin on page 417.

SC 503




**10 MHz Dual Trace Storage Oscilloscope**

## SC 503

- **10 MHz Bandwidth**
- **Bistable Storage Autoerase**
- **Trigger View**
- **Variable Holdoff**
- **Switchable Front/Rear X and Y Inputs**
- **Rear Z-Axis Input**
- **True X-Y Capability**

The SC 503 is a nondelayed sweep, general purpose storage oscilloscope which can be used to store and display waveforms after the input signal is removed. This feature is particularly useful when measuring slow repetition rates or single-shot signals, important in the biomedical and mechanical measurements fields. Low frequency signals at heart or respiration rates can be stored for detailed analysis. In the mechanical measurements field the SC 503 can "freeze" fast or transient signals from transducers, which is especially useful in pressure-and velocity-versus-time analysis and shock testing.

Other important storage applications of the SC 503 include measurements of signals in computer peripherals, communication terminals and industrial control systems.

The SC 503 also features an auto-erase mode that erases the stored signal and automatically retriggers the oscilloscope, and X-Y capability. The X-Y capability allows creation of Lissajous patterns in many cause and effect testing relationships including: acoustic speech testing, nerve potential testing, and optical stimulus response testing. The Tektronix P6108 and P6062B probes are recommended for use with the SC 503.

## CHARACTERISTICS

### VERTICAL DEFLECTION

**Bandwidth at −3 dB Points** — Dc to at least 10 MHz, (5 mV/div to 20 mV/div); dc to at least 7 MHz (2 mV/div), dc to at least 5 MHz (1 mV/div).

**Risetime** — 5 mV to 20 V/div, typically 35 ns or less.

**Ac Low-Frequency Response (Lower −3 dB Points)** — Without probe, 10 Hz; with 10X probe 1 Hz.

**Deflection Factors** — Calibrated Range: 1 mV/div to 20 V/div, 14 steps in a 1-2-5 sequence. Accuracy: 5 mV to 20 V/div (+15°C to +35°C) ±3%, 1 mV/div and 2 mV/div ±5%; (derate accuracy by additional 1% for 0°C to +50°C). Uncalibrated Range: At least 2.5:1 continuously variable between calibrated steps. Extends maximum uncalibrated deflection factor to at least 50 V/division.

**Modes** — CH 1, CH 2, Alt, Chop, CH 1 minus CH 2, CH 1 plus CH 2, X-Y. Chop rate at least 250 kHz.

**Input Impedance** — 1 MΩ ±1% paralleled by ≈47 pF.

**Maximum Input Voltage** — 350 V (dc + peak ac), 700 V p-p ac at 1 kHz or less. Above 1 kHz recommended p-p ac limit is 250 V to 10 kHz derating to 25 V above 100 kHz.

**Common-Mode Rejection Ratio** — At least 50:1 at 1 MHz when using same attenuator setting, in CH 1 minus CH 2 mode.

**Delay Line** — Permits viewing leading edge of displayed waveform.

**Calibrator** — 0.6 V, ±1%, ≈1 kHz frequency.

**Position Range** — ±6 div.

**Channel Isolation** — 2% or less display related crosstalk to 10 MHz.

**Displayed Noise** — <0.2 mV p-p at 1 mV/div.

### HORIZONTAL DEFLECTION

**Sweep Generator** — Calibrated Sweep Rates: 2 s/div to 0.5 μs/div, 21 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates to 50 ns/div. Uncalibrated (variable) range provides continuously variable sweep rates, between the calibrated rates, and extends the slowest rate of at least 5 s/div.

**Sweep Rate Accuracy*1**

| +15°C to +35°C | X1 | X10 |
|---|---|---|
| 2 s/div to 0.5 s/div | ±4% | ±5% |
| 0.2 s/div to 5 μs/div | ±3% | ±4% |
| 2 μs/div to 0.5 μs/div | ±4% | ±5% |

*1 *Derate accuracy by an additional 1% from 0°C to +15°C and +35°C to +50°C.*

**X-Y Mode** — Bandwidth: Dc to at least 500 kHz. Deflection Factor: Selected by CH 2 controls and Horizontal Mag X1, X10. Phase Difference: <3° at 50 kHz or less.

### TRIGGER

**Trigger Modes** — Auto (enhanced), Norm, and Sgl Swp (single sweep).

**Enhanced Auto Trigger** — The trigger circuit automatically adjusts to spread the p-p signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

**Trigger Sources** — CH 1, CH 2, Line, Ext, Int (rear interface).

**Trigger Coupling** — Dc, ac, ac LF Rej.

**Trigger Sensitivity*1** — Minimum p-p signal required.

| Source | dc to 5 MHz | 5 MHz to 10 MHz |
|---|---|---|
| CH 1, CH 2 | 0.4 div | 1.0 div |
| External | 60 mV | 150 mV |
| Interface | Typically 35 mV | Typically 80 mV |

*1 *With ac coupling requirements increase below ≈50 Hz. With ac LF Rej coupling requirements increase below ≈10 kHz.*

**Triggering Level Range** — External: At least ±1.2 V. Internal: At least −6.0 div.

**External Triggering Input** — Input Impedance: 1 MΩ, paralleled by ≈47 pF. Maximum Input Voltage: 350 V (dc + peak ac), 350 V p-p at 1 kHz or less. Above 1 kHz recommended p-p ac limit is 100 V to 10 kHz derating to 10 V above 100 kHz.

**Auto Mode** — Sweep free-runs in the absence of a triggering signal. Level control range automatically varies with the triggering signal amplitude for frequencies above 100 Hz.

**Single Sweep** — Triggering requirements same as for normal sweep. When triggered, sweep generator produces one sweep only.

**Trigger Holdoff** — At least 20 to 1 range. The variable control is internally selectable between the Variable Sweep or Variable Holdoff functions.

### STORAGE SYSTEM

**Stored Writing Speed (Center 6 x 8 Divisions)** — At least 80 div/ms (50 cm/ms).

**Erase Time** — 400 ms to 600 ms.

**Autoerase Viewing Time** — Continuously variable from ≤0.5 s to ≥5 s.

**Maximum Recommended Storage Time** — ≈4 hrs.

### CRT

**Phosphor** — GX (P44).

**CRT Graticule** — 8 x 10 div., 0.25 in/div (0.64 cm/div). Internal graticule lines.

### REAR INTERFACE

**CH 1 and CH 2 Vertical Inputs** — Selected by CH 1 and CH 2 coupling in Int (interface) position. Input Impedance: 50 Ω. Can be customer-modified for input impedance of 1 MΩ paralleled by ≈100 pF.

**Trigger Input** — Selected by Trigger Source switch in Int (interface) position. Input Impedance: 50 Ω, when selected, 25 Ω when not selected. Can be customer-modified for input impedance of 1 MΩ paralleled by ≈60 pF.

**Z-Axis Input** — Input Impedance: ≈1.5 kΩ. +5 V turns beam On from Off condition, −5 V turns beam Off from On condition.

**CH 1 Output** — At least 50 mV/div. Bandwidth: At least 4 MHz. Output Impedance: 50 Ω.

**Ramp Output** — 0 V to +10 V ramp Output impedance ≈500 Ω.

**Included Accessory** — Instruction manual.

## ORDERING INFORMATION

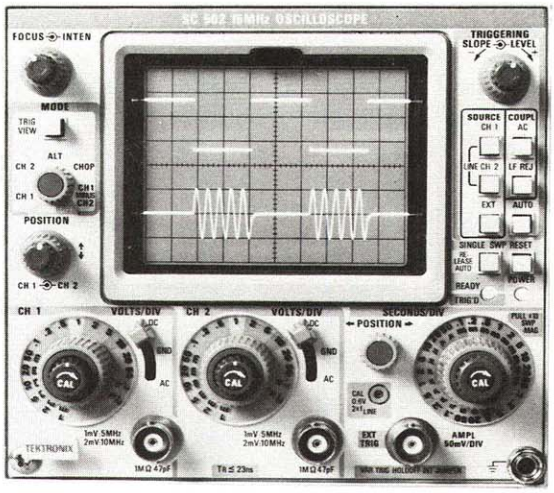
**SC 503** 10 MHz Storage Oscilloscope
..... **$3,650**

### RECOMMENDED PROBES

P6101 1X, P6108 10X, P6062B 1X/10X. See pages 450 and 454.

Compatible accessories begin on page 417.

**SC 502**




**15 MHz Dual-Trace Oscilloscope**

## SC 502

**15 MHz Bandwidth**

**Dual-Trace**

**20 ns/div Maximum Calibrated Sweep Rate**

**1 mV/div Maximum Sensitivity**

**Delay Line**

**Trigger View**

**Variable Trigger Hold-off**

**Enhanced Automatic Triggering**

The SC 502 is a compact general-purpose 15 MHz dual-trace oscilloscope designed to operate in any two adjacent compartments of a TM 500 power module/mainframe. It has a high writing speed, a wide range of sweep rates, a wide range of deflection factors, and versatile triggering, including trigger view and enhanced automatic triggering.

As with many Tektronix products, the SC 502 features circuits, subcircuits, and components designed and built by Tektronix to fulfill the special design capabilities of the instrument. Among its many recommended uses, the SC 502 is intended to be a powerful tool in the field servicing of digital equipment, where it would be used in association with disk memories, key-to-tape, printers, plotters, punches, readers, and terminals. The CRT of the SC 502 offers a high writing speed as an advantage in the display of digital information, while stable, clean triggering is assured by incorporating well proven circuits. Thus, the SC 502 offers the engineer a unique combination of performance, compactness, and systems capability.

The SC 502 makes many new instrumentation systems feasible, especially in the areas of QA, production testing, maintenance, and field servicing. The rear interfacing capability of the SC 502 and all TM 500 Instrumentation suggests exceptional applicability to systems of built-in test equipment or rackmounted installations. The TM 515 Traveler mainframe with the SC 502, forms a nucleus for sophisticated, compact field service "packages." The Tektronix P6062B and P6108 are recommended for use with the SC 502.

## CHARACTERISTICS

### VERTICAL DEFLECTION

**Bandwidth at −3 dB Points** — 5 mV to 20 V/div, dc to at least 15 MHz; 2 mV/div, dc to at least 10 MHz; 1 mV/div, dc to at least 5 MHz.

**Risetime** — 5 mV to 20 V/div, 23 ns or less.

**Ac Low-Frequency Response (Lower −3 dB Points)** — Without probe, 10 Hz; with probe (10X), 1 Hz.

**Deflection Factors** — Calibrated Range: 1 mV to 20 V/div, 14 steps in a 1-2-5 sequence. Accuracy: 5 mV to 20 V/div (+15°C to +35°C) within 2%, (0°C to +50°C) within 3%; 1 mV and 2 mV/div within 5%. Uncalibrated (Variable) Range: At least 2.5:1. Continuously Variable Between Calibrated Steps: Extends maximum attenuator step to at least 50 V/div.

**Modes** — CH 1, CH 2, Alt, Chop, CH 1 Minus CH 2. Chop rate at least 250 kHz. Triggering waveform is displayed instead of selected display when desired.

**Input Impedance** — 1 MΩ within 1% paralleled by ≈47 pF.

**Maximum Input Voltage** — 350 V (dc + peak ac), 700 V p-p at ac 1 kHz or less.

**Common-Mode Rejection Ratio (CH 1 Minus CH 2 Mode)** — At least 50:1 at 1 MHz when using same attenuator setting.

**Channel Isolation** — 2% or less display related crosstalk to 15 MHz.

**Displayed Noise** — ≤0.2 mV p-p at 1 mV/div.

**Position Range** — ±6 div.

**Calibrator** — Voltage, 0.6 V ±1%. Frequency, twice the power line frequency.

### HORIZONTAL DEFLECTION

**Sweep Generator** — Calibrated Sweep Rates: 0.5 s to 0.2 μs/div, 20 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates to 20 ns/div. Uncalibrated (Variable) Range: The Cal (variable) control provides sweep rates that are continuously variable between the calibrated rates, and extends the slowest sweep rate to at least 1.25 s/div.

**Sweep Rate Accuracy** — Within 3% unmagnified, 4% magnified, +15°C to +35°C. Derated by an additional 1% for 0°C to +15°C and +35°C to +50°C.

**External Horizontal Amplifier** — Bandwidth: Dc coupled, dc to at least 2 MHz; ac coupled <50 Hz to at least 2 MHz. Deflection Factor: 50 mV/div within 5%. X and Y Amplifier Phase Difference: <3° at 50 kHz or less. Input Impedance: 1 MΩ within 2% paralleled by ≈47 pF. Maximum Input Voltage: 350 V (dc + peak ac); 350 V p-p at 1 kHz or less.

### TRIGGER

**Enhanced Automatic Triggering** — In the automatic mode, the trigger circuit automatically adjusts to spread the p-p signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

**Trigger Modes** — Auto (enhanced), Normal (auto button out), Single Sweep.

**Trigger Sources** — CH 1, CH 2, Line Ext.

**Trigger Coupling** — Dc, ac, ac LF Rej.

**Trigger Sensitivity**[*1]

| Source | dc to 5 MHz | 5 MHz to 15 MHz |
|---|---|---|
| CH 1, CH 2 | 0.4 div | 1.0 div |
| External | 60 mV | 150 mV |

*[*1] Minimum p-p signal required.*

With ac coupling requirements increase below ≈50 Hz. Ac LF Rej coupling requirements increase below ≈5 kHz.

**Triggering Level Range** — Internal: At least ±8 division. External: At least ±1.2 V.

**External Triggering Input** — Input Impedance: 1 MΩ within 2% paralleled by ≈47 pF. Maximum Input Voltage: 350 V (dc + peak ac); 350 V p-p ac at 1 kHz or less.

**Auto Mode** — Sweep free-runs in the absence of a triggering signal. Trigger Level range is reduced to approximately the p-p range of the triggering signal.

**Single Sweep** — Triggering requirements same as for normal sweep. When triggered, sweep generator produces one sweep only. Auto push button must be in the Out position for operation and for setting triggering controls.

**Trigger Holdoff** — At least 20 to 1 range. The Variable control is internally selectable between the Variable Sweep or Variable Holdoff functions.

### CRT

**Phosphor** — GH (P31) is standard.

**Deflection** — Electrostatic.

**Acceleration Potential** — ≈12 kV.

**Graticule** — Scale, 8 x 10 division with 0.25 in/div internal graticule lines.

**Included Accessory** — Instruction manual.

## ORDERING INFORMATION

**SC 502** 15 MHz Oscilloscope ..... **$2,480**

### RECOMMENDED PROBES

P6101 1X, P6108 10X, P6062B 1X/10X. See pages 450 and 454.

Compatible accessories begin on page 417.

## PRODUCT SUMMARY

The CG 5001 is the computerized solution to large-scale scope calibration needs. The CG 5001 can be used as part of a computer-based system to calibrate and verify all major oscilloscope parameters, and is specifically designed for use where many oscilloscopes are maintained. Its programmability, combined with state-of-the-art performance, helps to minimize calibration lab labor while maximizing accuracy of verification checks.

In addition to the CG 5001, TM 500 offers a complete set of calibration instruments that can be configured into a portable test set for in-field oscilloscope service and calibration. These TM 500 oscilloscope calibration instruments offer the widest range of standard amplitude squarewaves, fastest risetimes, lowest aberrations, fastest time marks and widest frequency range of leveled sinewaves available today.

The TG 501 Time Mark Generator provides crystal-controlled time marks from 5 s to 1 ns, plus a variable mode of operation which allows you to read the oscilloscope's timing error directly in percent from the digital display.

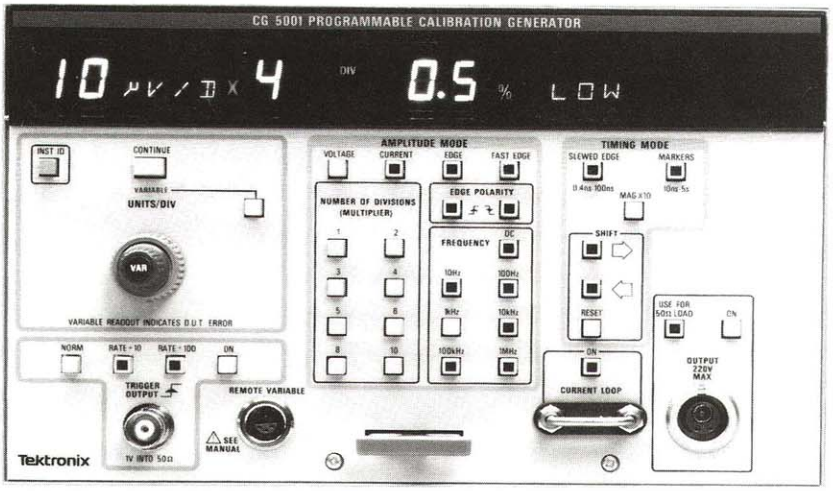
The PG 506 Calibration Generator provides clean, fast-rise squarewaves for checking oscilloscope transient response and calibrated-amplitude squarewaves for checking and setting the vertical amplifier gain of the oscilloscope. Like the TG 501, the PG 506 has a variable mode of operation which allows you to read the oscilloscope's calibration error directly in percent from its digital display.

The SG 503 and SG 504 generators provide leveled sinewaves for bandwidth checks (−3 dB points) and triggering performance checks. The SG 503 is a general-purpose leveled sinewave oscillator providing variable output from 250 kHz to 250 MHz. The SG 504 provides a leveled sinewave output that is variable from 245 MHz to 1050 MHz in two bands. The SG 502 Oscillator benefits calibration applications where verification of low frequency rolloff in ac modes and performance measurement of low-frequency-reject triggering modes is required.

**OSCILLOSCOPE CALIBRATION PRODUCT GUIDE**

| | Primary Functions | Secondary Functions |
|---|---|---|
| CG 5001 Programmable Calibration Generator | Amplitude Calibration 40 μV to 200 V Time Base Calibration 0.4 ns to 5 s | Testing risetime and transient response, attenuator compensation, oscilloscope nonlinearity |
| PG 506 Calibration Generator | Amplitude Calibration 200 μV to 100 V | Testing risetime and transient response, attenuator compensation |
| TG 501 Time Mark Generator | Time Base Calibration 1 ns to 5 s | Testing oscilloscope nonlinearity |
| SG 503 Signal Generator | Bandwidth Calibration 250 kHz to 250 MHz | General leveled RF signal source |
| SG 504 Signal Generator | Bandwidth Calibration 245 MHz to 1050 MHz | General leveled RF signal source with frequency modulation capability |

**CG 5001**




**Programmable Oscilloscope Calibration Generator**

## GPIB IEEE-488 CG 5001

The CG 5001 is designed to support other products which comply with IEEE Standard 488-1978.

The Tektronix CG 5001 Programmable Oscilloscope Calibration Generator is a microprocessor-based generator that can be used as part of a computerized system for the calibration and verification of major oscilloscope parameters, including:

- **Vertical Gain**
- **Horizontal Timing and Gain**
- **Vertical Bandwidth/Pulse Characteristics**
- **Probe Accuracy and Compensation**
- **Current Probe Accuracy**
- **Calibrator Output Accuracy**

The CG 5001's front panel features a wide range of functions, many of which represent a new state-of-the-art in calibration performance. All these functions are programmable by a controller via the GPIB (General Purpose Interface Bus). A "Learn" mode allows any manually-set function or range to be acquired by a controller. Subsequent use of the resulting program requires a minimum of operator skill and makes data logging an automatic operation.

This computer-assisted test and calibration system can provide step-by-step instructions to the operator, thus significantly reducing the skill level required.

Many of the calibration and test steps previously performed by the operator can now be transferred to a computer which executes them in a consistent and error-free manner. To calibrate a particular oscilloscope, the computer's program can send control-setting information to the CG 5001, which then sends the appropriate calibration signals to the oscilloscope. At the same time, a series of operator instructions can be placed on a terminal to automatically coordinate the operator with the calibration signals being sent from the CG 5001. The operator follows these instructions to make the necessary settings of the oscilloscope controls as the calibration or test procedure progresses. The CG 5001 returns error or deviation information to the controller, where it can be compared with preprogrammed reference values for the oscilloscope. A permanent record of the entire maintenance procedure can be stored by the controller and can be printed via peripherals such as a hard copy unit or line printer. Throughout the process, all calibration settings are determined by the computer's program. All front panel settings on the oscilloscope are specified in detail for the operator. Calculations of error percentages are performed automatically.

The CG 5001 is designed to greatly reduce your maintenance costs. Built-in self test routines and hardware check the operation of all major circuits each time the power is turned on.

Modular construction means that all circuit boards unplug (except the Main Interconnect) for easy exchange if service is required. A signature analysis mode is included to facilitate troubleshooting of the digital portion of the instrument.

### CHARACTERISTICS

**VOLTAGE (AMPLITUDE MODE)**

The standard voltage is used to calibrate vertical display accuracy.

**Range** — 40 μV to 200 V (1-2-5 steps with multiplier).

**Multipliers** — 1, 2, 3, 4, 5, 6, 8, 10 divisions.

**Polarity** — Positive from ground.

**Accuracy** — +0.25% ±1 μV.

**Frequency** — 40 mV to 80 mV: 10 Hz to 100 kHz. 100 mV to 10 V: dc or 10 Hz to 100 kHz. 12 V to 200 V: dc or 10 Hz to 10 kHz.

**Variable Range** — ±9.9%.

### CURRENT (AMPLITUDE MODE)

The standard current is used to calibrate current probes.

**Range** — 1 mA to 100 mA (1-2-5 sequence).

**Multipliers** — 1, 2, 3, 4, 5, 6, 8, 10.

**Accuracy** — ±0.25% ±2 μA.

**Frequency** — Dc or 10 Hz to 1 MHz (decade steps).

**Droop** — ≤1%.

**Variable Range** — ±9.9%.

### LOW EDGE (AMPLITUDE MODE)

The Low Distortion Pulse obtained in this mode is used to test oscilloscope input amplifier and attenuator compensation.

**Range** — 20 mV to 1 V p-p (50 Ω load only) (1-2-5 steps with multipliers).

**Multipliers** — 1, 2, 3, 4, 5, 6, 8, 10.

**Polarity** — Positive or negative transitions to ground.

**Risetime (Falltime)** — ≤1.3 ns.

**Abberrations** — ±2%.

**Long Term Flatness** — ±0.5% after first 10 ns.

**Frequency** — 10 Hz to 1 MHz (decade steps).

**Variable Amplitude Range** — > ±9.9% from nominal.

### HIGH EDGE (AMPLITUDE MODE)

The Low Distortion Pulse obtained in this mode is used to test oscilloscope input amplifier and attenuator compensation.

**Range** — 1.2 V to 100 V ≥1 MΩ load (1-2-5 steps with multipliers).

**Polarity** — Positive transition only (negative voltage to ground).

**Risetime** — <100 ns.

**Aberrations** — ±2% of squarewave amplitude.

**Long Term Flatness** — ±0.5% after first 500 ns.

**Frequency** — 10 Hz to 100 kHz (decade steps).

**Variable Amplitude Range** — > ±9.9% from nominal.

### MARKERS (TIMING MODE)

The markers obtained in this mode are used to calibrate oscilloscope time bases.

**Range** — 10 ns to 5 s (1-2-5 steps).

**X10 Magnifier** — Increase marker rate by a factor of ten (0.1 μs to 5 s range).

**Accuracy** — ±0.01% (optional TCXO ±0.0003%).

**Amplitude** — 1 V minimum into 50 Ω.

**Variable Range** — ±9.9%.

### SLEWED EDGE (TIMING MODE)

Slewed Edges are used to calibrate the very fastest ranges found on oscilloscope time bases.

**Range** — 0.4 ns to 100 ns (1-2-5 steps plus 0.4 ns).

**X10 Magnifier** — Increases Slewed Edge rate by a factor of ten (5 ns to 100 ns range).

**Accuracy** — ±0.01% (Optional TCXO ±0.0003%).

**Edge Position Uncertainty** — ±40 ps.

**Amplitude** — >1 V into 50 Ω.

**Variable Range** — ±9.9%.

### TRIGGER OUTPUT

The oscilloscope under test is normally triggered externally from this source.

**Output Amplitude** — 1 V minimum into 50 Ω.

**Trigger Rate (Marker Mode)** — Normal: Slaved to marker rate from 100 ns to 5 s; remains at 100 ns for faster markers. Divided by 10: Reduces normal trigger rate by a factor of ten. Divided by 100: Reduces normal trigger rate by a factor of one hundred.

**Slewed Edge Mode** — One trigger per slewed edge.

**All Other Modes** — Normal: Slaved to output frequency. Divided by 10: One-tenth output frequency. Divided by 100: One-hundredth output frequency.

### TIMING REFERENCE OUTPUT

### EXTERNAL TIMING REFERENCE

**Input Frequency** — Any integral multiple of 1 MHz up to 5 MHz.

**Required Accuracy** — ±0.001%.

**Input Amplitude** — 1 V to 10 V RMS.

**Input Resistance** — 10 kΩ (nominal).

### ENVIRONMENTAL

Meets or exceeds MIL-T-28800B, Class 5 requirements.

**Temperature** — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Relative Humidity** — 90% to 95% at +50°C for 5 days.

**Altitude** — Operating: 4500 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

**Vibration** — Operating: Displacement (p-p), 0.015 inch. Vibration Frequency: 10 Hz to 55 Hz. Total time: 75 minutes.

**Shock** — Nonoperating: 30 g's, ½ sine, 11 ms duration, three shocks in each direction along three major axes; total shocks, 18.

**Bench Handling** — Operating: 45° 4 inches or point of balance, whichever occurs first.

### PHYSICAL CHARACTERISTICS*[1]

| Dimensions | mm | in |
|---|---|---|
| Width | 203 | 8.0 |
| Height | 124 | 4.9 |
| Depth | 305 | 12.0 |
| **Weights** | **kg** | **lb** |
| Standard | 3.9 | 8.5 |
| Option 01 | 4.0 | 8.7 |

*[1] *Maximum Overall Dimensions (triple compartment plug-in).*

### PULSE HEAD (STANDARD ACCESSORY)

### FAST EDGE (AMPLITUDE MODE)

The Pulse Head is used to generate fast rise, low distortion pulses for testing higher bandwidth vertical amplifiers.

**Amplitude** — 1.1 V peak ±5% into 50 Ω.

**Adjustable Range** — ±10%.

**Risetime** — ≤200 ps.

**Polarity** — Positive or negative transitions from ground.

**Aberrations** — ±3% of pulse amplitude; not to exceed 4% p-p for adjacent peaks.

**Frequency** — 100 Hz to 100 kHz (decade steps).

### INCLUDED ACCESSORIES

Output cable assembly (012-0884-00); pulse head (015-0311-01); instruction manual.

### MAINFRAMES

CG 5001 requires either a TM 5003 or TM 5006. The CG 551AP is a TM 500 version of the CG 5001 and requires a TM 506 Mod JB, TM 515 Mod UB or RTM 506 Mod JB. The CG 5001 is not compatible with TM 500 power module mainframes.

## ORDERING INFORMATION

**CG 5001** Programmable Calibration Generator ..... **$14,460**

**CG 551AP** Programmable Calibration Generator ..... **$14,460**

**Option 01** — Adds High Accuracy Time Base (TCXO) CG 5001/CG 551AP. ..... **+$650**

**Option 02** — Deletes Pulse Head CG 5001/CG 551AP. ..... **−$1,100**

**Utility Software**
For TM 5000/4041. Order 062-6958-01 ..... **$150**
For TM 5000/4052A. Order 062-6957-01 ..... **$150**
Refer to page 323 for description and ordering information.

### OPTIONAL ACCESSORIES

**Comparator Head** — Used to calibrate built-in oscilloscope calibrators against the signals available from the CG 5001. Both the oscilloscope calibrator and CG 5001 standard amplitude signals are applied to the Comparator Head and simultaneously displayed on the oscilloscope CRT. The CG 5001 signals are then varied to obtain congruent displays. Errors are then displayed on the CG 5001 readout.
Order 015-0310-01 ..... **$500**

**Remote Variable** — Permits remote operation of the following front panel controls: Units/Div, Variable-Fixed Button, Continue Pushbutton and the VAR. Order 015-0309-01 ..... **$375**

**Pulse Head** — Order 015-0311-01 ..... **$1,400**
(When purchased separately.)

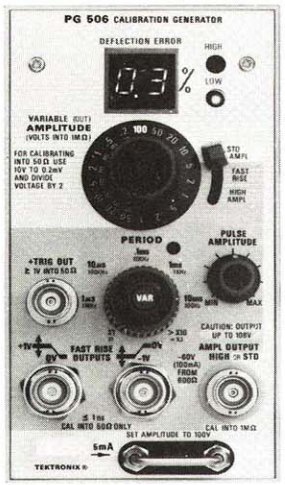
**SCPDA I** — (ScopeCal Procedure Development Aid and 465B Verification Program) 4052A ..... **$100**

**Rigid Circuit Board Extender** —
Order 067-0975-00 ..... **$100**

**Flexible Circuit Board Extender** —
Order 067-0974-00 ..... **$115**

**CG 551AP** — Field Modification Kit to convert to CG 5001.
Order 040-1041-02 ..... **$115**

**PG 506**




**Calibration Generator**

## PG 506

### Three Squarewave Output Modes

### 10 Hz to 1 MHz

### Direct Readout of Oscilloscope Deflection Error

The PG 506 Calibration Generator provides three modes of squarewave output, selectable dc outputs, and a variable-amplitude output with front-panel digital indication of oscilloscope deflection error. Simultaneous plus and minus low-level, fast-rise (1.0 ns) squarewaves or high amplitude (60 V), extremely clean squarewaves are available at frequencies from 10 Hz through 1 MHz for checking oscilloscope transient response. A 5 mA calibration current loop is useful for current probe calibration. A 1 kHz squarewave can be generated in the amplitude calibration mode. Its amplitude may be varied around the calibrated level until the squarewave aligns with the oscilloscope vertical graticule divisions. Scope deflection error then can be read directly off the PG 506 digital display in percentage high or low, permitting rapid verification of oscilloscope performance.

### CHARACTERISTICS

#### AMPLITUDE CALIBRATOR MODE

**Period** — Fixed at ≈1 ms or dc.

**Amplitude** — From 200 μV p-p to 100 V p-p in 1-2-5 sequence, accurate within ±0.25% into 1 MΩ. 100 μV p-p to 5 V p-p into 50 Ω.

**Error Readout** — Range: ±7.5%. Resolution: 0.1%.

#### PULSE MODES

**Period** — 1 μs to 10 ms (within 5%) in decade steps with the variable control in Cal position. Variable extends period to at least 100 ms.

**Symmetry** — ≈50% duty cycle.

#### HIGH AMPLITUDE OUTPUT

**Risetime** — Unterminated: 100 ns or less. Terminated into 50 Ω: 10 ns or less.

**Amplitude Range** — Unterminated: 6 V or less to at least 60 V. Terminated into 50 Ω: 0.5 V or less to at least 5 V.

**Leading Edge Aberrations** — Within 2% or 50 mV p-p, whichever is greater, when terminated into 50 Ω.

**Polarity** — Positive going from a negative potential to ground.

**Output Resistance Source** — 600 Ω within 5%.

#### FAST-RISE OUTPUTS

**Risetime (Terminated Into 50 Ω)** — 1.0 ns or less.

**Amplitude Range (Terminated Into 50 Ω)** — 100 mV or less to at least 1.0 V.

**Leading Edge Aberrations** — Within 2% or 10 mV p-p, whichever is greater, during first 10 ns.

**Flatness** — Within 0.5% after first 10 ns.

**Polarity** — Simultaneous positive and negative going. Positive going is from a negative rest potential to ground. Negative going is from a positive rest potential to ground.

**Output Resistance Source** — 50 Ω within 3% at + and − output connectors.

**Trigger Output (Terminated into 50 Ω)** — Positive-going signal of at least 1 V.

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**PG 506** Calibration Generator ..... **$2,700**

### TUNNEL DIODE PULSER

The Tunnel Diode Pulser provides a clean, fast-rise pulse for adjusting the transient response of high-frequency oscilloscopes and other instruments. The Tunnel Diode Pulser can be driven by the PG 506 Calibration Generator at repetition rates exceeding 50 Hz. Output amplitude of the pulse is approximately 250 mV into 50 Ω, while risetime is ≤125 ps; aberrations are <1% in a 1 GHz system.

### ORDERING INFORMATION

**Tunnel Diode Pulser**
Order 067-0681-01 ..... **$165**

### PRECISION VOLTAGE DIVIDER

Designed for use with the PG 506 in the Standard Amplitude mode, this 0.4 divider allows your oscilloscope to display a constant four divisions when checking amplitude calibration from 20 μV/div through 1 V/div. It also allows the PG 506 to be more conveniently used with oscilloscopes that cannot display five divisions of amplitude.

### CHARACTERISTICS

**Input Z** — 50 Ω with output load ≥100 kΩ.

**Maximum Input** — ≤5 V RMS.

**Output** — 0.4 x PG 506 amplitude.

**Voltage Accuracy** — ±0.4%.

### ORDERING INFORMATION

**Precision Voltage Divider**
Order 015-0265-00 ..... **$140**

**TG 501**

**Time Mark Generator**

## TG 501

### Marker Outputs, 1 ns to 5 s

### Direct Readout of Oscilloscope Timing Error

### External Trigger Output

The TG 501 Time Mark Generator provides marker outputs from one nanosecond to five seconds. A unique feature on the TG 501 is a variable timing output with a front-panel two-digit LED display. The display indicates percentage of timing error between the normal time interval and a variable interval set to line up the marker pulse with graticule or division mark on the display. This feature not only provides direct readout in terms of percent error, but also helps eliminate errors associated with visually estimating error from a display.

### CHARACTERISTICS

**Markers** — 1 ns through 5 s in a 1-2-5 sequence.

**Marker Amplitude** — ≥1 V peak into 50 Ω on 5 s through 10 ns markers. ≥750 mV p-p into 50 Ω on 5 ns and 2 ns markers. ≥200 mV p-p into 50 Ω on 1 ns markers.

**Trigger Output Signal** — Slaved to marker output from 5 s through 100 ns. Remains at 100 ns for all faster markers.

| Internal Time Base | Standard | Option 01 |
|---|---|---|
| Crystal Frequency | 1 MHz | 5 MHz |
| Stability (0°C to 50°C) after ½ hour | within 1 part in $10^5$ | within 5 parts in $10^7$ |
| Long-Term Drift | 1 part or less in $10^5$ per month | 1 part or less in $10^7$ per month |
| Setability | adjustable to within 1 part in $10^7$ | adjustable to within 5 parts in $10^9$ |

**External Reference Input** — Available with internal changes. Acceptable frequencies, 1 MHz, 5 MHz, or 10 MHz. Input amplitude must be TTL compatible.

**Timing Error Readout Range** — To ±7.5%.

**Timing Error Measurement Accuracy** — Device under test error is indicated to within one least significant digit (to within one displayed count).

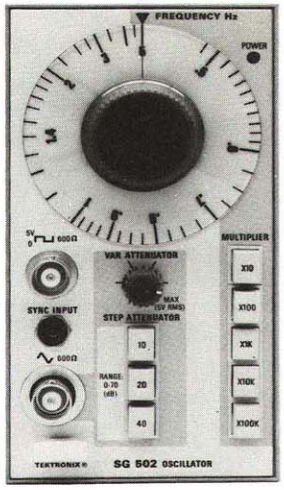
**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**TG 501** Time Mark Generator ..... **$2,175**
**Option 01** — 5 MHz Time Base ..... **+$325**

For compatible accessories - refer to page 458.

**SG 502**




**Oscillator**

## SG 502

**5 Hz to 500 kHz Sinewaves and Squarewaves**

**Low Distortion Sinewave**

**5 V RMS Open Circuit—600 Ω Source**

**0 dB to 40 dB Output Variable Plus 0 dB to 70 dB in 10 dB Steps**

The SG 502 Oscillator features a wide frequency range of 5 Hz to 500 kHz with low distortion (0.035% between 20 Hz and 50 kHz) and is desirable for general test purposes. Other SG 502 features include 70 dB amplitude control plus a simultaneous fixed amplitude squarewave.

### CHARACTERISTICS

#### SINEWAVE

**Frequency Range** — 5 Hz to 500 kHz in 5 decade steps. Accurate within 5% of dial setting from 5 Hz to 50 kHz; within 10% of dial setting from 50 kHz to 500 kHz.

**Amplitude Response (1 kHz Reference)** — Flatness is 0.3 dB over entire range.

**Attenuation** — Selectable from 0 dB to 70 dB in 10 dB, 20 dB, and 40 dB steps with push buttons. Accurate within 0.2 dB for each step selected, additive. An uncalibrated control provides continuous variation from 0 dB to −40 dB.

**Harmonic Distortion** — <0.035% (−70 dB) from 20 Hz to 50 kHz. <0.15% from 50 kHz to 500 kHz ($R_L \geq 600\ \Omega$).

**Maximum Output Voltage** — 5 V RMS open circuit; 2.5 V RMS into 600 Ω.

**Output Impedance** — 600 Ω, grounded.

#### SQUAREWAVE

**Frequency Range and Accuracy** — Same as sinewave. The squarewave switches on the 0° phase of sine out.

**Risetime and Falltime** — 50 ns or less.

**Amplitude** — +5 V, fixed, open circuit.

**Output Impedance** — 600 Ω, grounded.

#### SYNC INPUT

Oscillator can be synchronized to external signal. Sync range, the difference between sync frequency and set frequency, is a linear function of sync voltage.

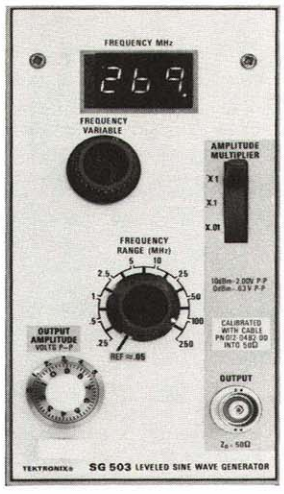
**Input Impedance** — 10 kΩ.

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**SG 502** Oscillator ..... **$875**

**SG 503**




**Signal Generator**

## SG 503

**250 kHz to 250 MHz**

**Leveled, Variable Output**

**Digital Readout of Frequency**

The SG 503 Signal Generator provides a leveled output that is variable in frequency from 250 kHz to 250 MHz. The selected frequency is indicated by a built-in autoranging frequency counter with a three-digit LED read-out on the front panel. Accurately calibrated output voltage is variable from 5 mV to 5.5 V peak-to-peak into 50 ohms.

### CHARACTERISTICS

**Frequency Range** — 250 kHz to 250 MHz, plus 50 kHz reference frequency.

**Frequency Accuracy** — Within ±0.7 of one count of the least significant digit of indicated frequency.

**Amplitude Range** — 5 mV to 5.5 V p-p into 50 Ω termination in three decade ranges.

**Amplitude Accuracy (50 kHz Reference)** — Within 3% of indicated amplitude on (X1) range, 4% on (X.1) range, and 5% on (X.01) range.

**Flatness (P-P)** — From 250 kHz to 100 MHz, output amplitude will not vary more than 1% of the value at 50 kHz except that up to +1.5%, −1% variation may occur between 50 MHz and 100 MHz on amplitude multiplier X.1 and X.01 ranges only. From 100 MHz to 250 MHz, amplitude variation is within 3% of the value at 50 kHz.

**Harmonic Content** — Second Harmonic: At least 35 dB down. Third Harmonic and All Higher Harmonics: At least 40 dB down.

**Other** — Rear edge card connection available to address the leveling circuit.

#### INCLUDED ACCESSORIES

Three foot precision 50 Ω cable (012-0482-00); instruction manual.

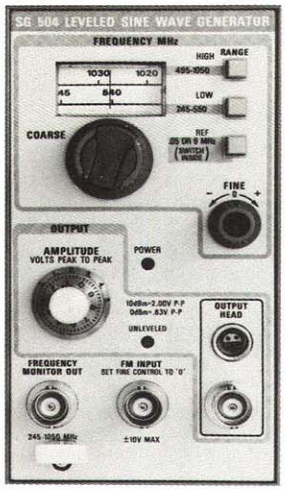
### ORDERING INFORMATION

**SG 503** Signal Generator ..... **$2,130**

**Tektronix offers service training classes on the TM 500 Calibration Systems Package. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.**

For compatible accessories — refer to page 458.

**SG 504**




**Signal Generator**

## SG 504

**245 MHz to 1050 MHz**

**Leveled, Variable Output**

**Frequency Modulation Capability**

The SG 504 Signal Generator provides a leveled output amplitude that is variable from 245 MHz to 1050 MHz in two bands. Frequency is indicated by a high-resolution tape dial that expands each band over 28 inches. The accurately calibrated output voltage is variable from 0.5 V to at least 4.0 V p-p into 50 Ω.

### CHARACTERISTICS

**Frequency Range** — Low Band: 245 MHz to 550 MHz. High Band: 495 MHz to 1050 MHz, plus 50 kHz or 6 MHz reference frequency (internally selected).

**Frequency Accuracy** — ±2% of dial indication.

**Amplitude Range** — 0.5 V to at least 4.0 V p-p.

**Amplitude Accuracy (At Reference)** — Within 3% of indicated amplitude.

**Flatness** — ±4% of amplitude at reference frequency.

**Harmonic Content** — Second Harmonic: At least 25 dB down. Third Harmonic and All Higher Harmonic: At least 40 dB down.

**FM Input** — Frequency Range: Dc to 100 kHz. Deviation Sensitivity: ±9 V produces from ±0.05% to ±0.5% deviation of carrier, depending on output frequency.

**Frequency Monitor Output** — ≥0.3 V p-p into a 50 Ω load from 245 MHz to 1050 MHz.

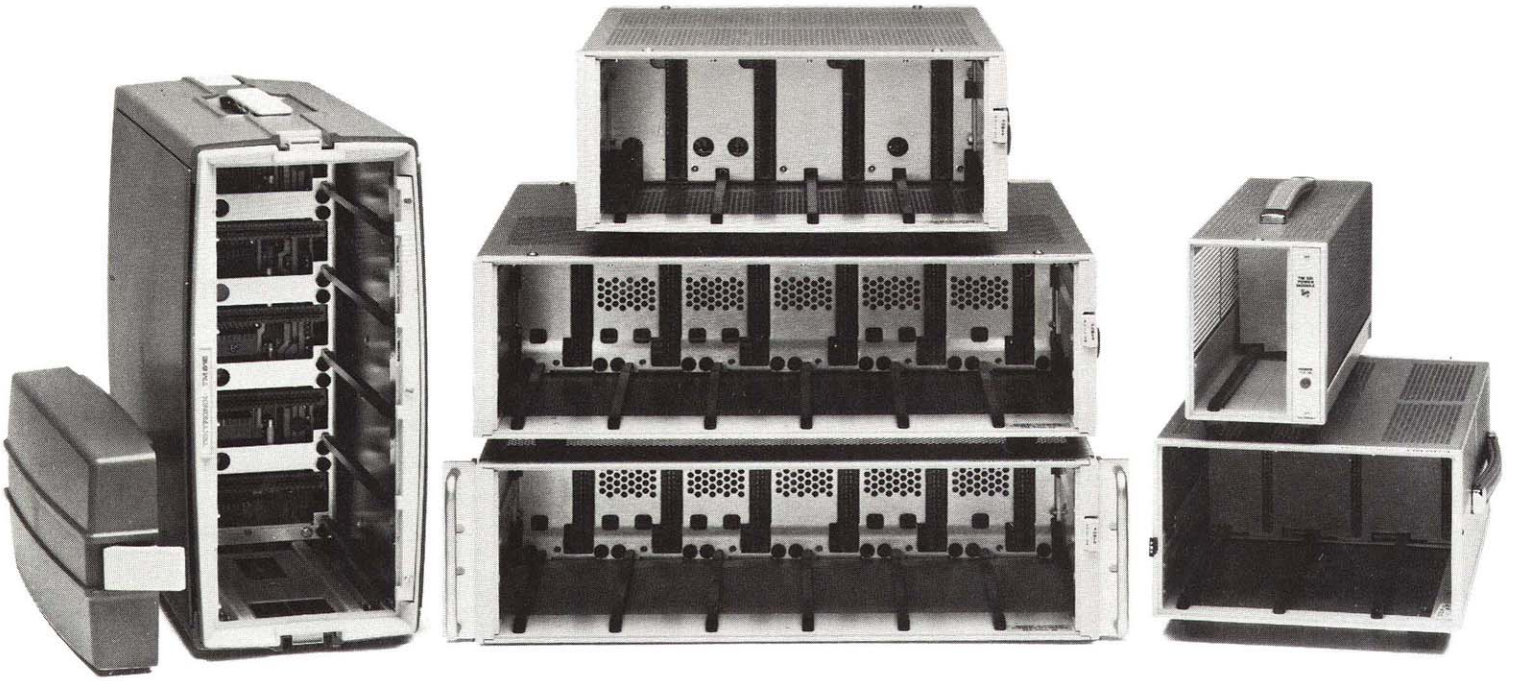
**Rear Card Edge Connections** — Address FM input, frequency monitor output, and amplitude control.

**Included Accessory** — Instruction manual.

### ORDERING INFORMATION

**SG 504** Signal Generator (Includes Leveling Head) ..... **$3,600**

**Replacement Leveling Head**
Order 015-0282-00 ..... **$450**



*Shown above are the TM 515, TM 504, TM 506, RTM 506, TM 501 and TM 503 mainframes.*

The TM 500 mainframes allow the multifunctionality of a package of instruments. Hundreds of instrumentation packages can be configured for specific tasks by using TM 500 plug-ins.

The TM 500 plug-ins operate in any of six mainframes that accept instruments in combinations of up to six single-width plug-ins. One single-width plug-in instrument is accommodated by the TM 501. Up to six instruments can be accommodated in the TM 506 bench-top mainframe and the RTM 506 rackmount mainframe. Three and four-wide mainframes are also available and the five-wide Traveler Mainframe provides for applications that require portability.

### Benchtop

There are four benchtop mainframes available. The TM 501 is the most compact. The TM 503 accommodates three single-wide plug-ins. The TM 504 and TM 506 each include a high-power compartment at the right-hand end to supply higher current levels to instruments that provide higher performance or higher output levels. The TM 506 incorporates a quiet fan for optimum cooling. All benchtop models have feet, tilt-bails, handles and front-panel power switches and operate from 110 V ac to 220 V ac.

### Portability

All benchtop models have carry handles for portable applications. Sturdy cordwrap rear feet plus optional protective front covers further enhance portable applications. The TM 515 traveler mainframe, designed for superior, multi-instrument portability, is a handsome piece of luggage with molded feet on the bottom and a comfortable, luggage-type handle. The TM 515 is extremely moisture and dust resistant and is designed to withstand the rigors of transport in car trunks and pickup trucks. The rear cover pops off to access the power cord and power switch and allow airflow for the built-in fan.

### Rackmount

The RTM 506 rackmount mainframe is electrically identical to the TM 506. It features a slide assembly and handles, plus a higher-power fan to accommodate the higher ambient temperatures often found in enclosed racks and consoles. It is also possible to convert two TM 503's into a rackmount assembly with a kit. This kit has the advantage of requiring four inches less depth than the RTM 506 for space-critical applications. but lacks the fan and the high-power compartments. Other kits are available to rackmount a single TM 503 or a TM 503 with a monitor.

### Rear Interface Capability

Most TM 500 plug-in modules contain a duplication of the front-panel input and output connections in the back. Some plug-in modules also have additional signal or control lines that are present only at the back of the instrument. These signals are available at the rear edge-card connector of each plug-in. Any module can be internally connected through the mainframe and also can be extenally interfaced out the back panel.

The TM 515 traveler mainframe is available with the Option 05 interface which includes everything in the Option 02 except the rear panel multi-pin connector, the mating cable connector, and the BNC connector.

### Economy

Reduced cabling costs made possible by the rear-interface capability, and the reduced space requirements for a measurement system all contribute to unprecedented economy for test and measurement requirements.

## CHARACTERISTICS

**ENVIRONMENTAL**

**Temperature Range** — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Altitude Range** — Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).

**POWER REQUIREMENTS**

All of the mainframes have manually selectable taps on the power transformer which permit operation on 100 V, 110 V, 120 V, 200 V, 220 V, or 240 V ±10%.

**Power Line Frequency Range** — TM 501/TM 503: 48 Hz to 440 Hz. TM 504/TM 506/RTM 506/TM 515: 48 Hz to 66 Hz. TM 515 (Purchased with Option 06): Extends upper power line frequency range to 440 Hz.

**Maximum Power Consumption** — See table below.

## ORDERING INFORMATION

**TM 501** Power Module Mainframe ..... **$350**
**Option 02** — Rear Interface ..... +$60

**TM 503** Power Module Mainframe ..... **$350**
**Option 02** — Rear Interface ..... +$90

**TM 504** Power Module Mainframe ..... **$450**
**Option 02** — Rear Interface ..... +$120

**TM 506** Power Module Mainframe ..... **$600**
**Option 02** — Rear Interface ..... +$180

**RTM 506** Rackmount Power Module Mainframe ..... **$710**
**Option 02** — Rear Interface ..... $190

**TM 515** Power Module Mainframe ..... **$675**
**Option 05** — Rear Interface ..... +$90
**Option 06** — 48 Hz to 440 Hz Fan ..... +$170

**MAINFRAME RACKMOUNT-TO-CABINET AND CABINET-TO-RACKMOUNT CONVERSION KITS**

**Cabinet-to-Rackmount Conversion Kit** — Equipped with slide-out assembly, required to rackmount two TM 503's side-by-side in a standard rack width. Order 040-0616-02 .... **$160**

**Cabinet-to-Rackmount Conversion Kit** — Equipped with slide-out assembly, required to rackmount a single TM 503 in a standard rack width. This includes securing hardware and a blank front panel when only one instrument is used. Order 040-0617-02 ..... **$240**

**Rackmount-to-Cabinet Conversion Kit** — Equipped to convert a rackmount TM 503 to a cabinet style. Order 040-0618-01 ..... **$70**

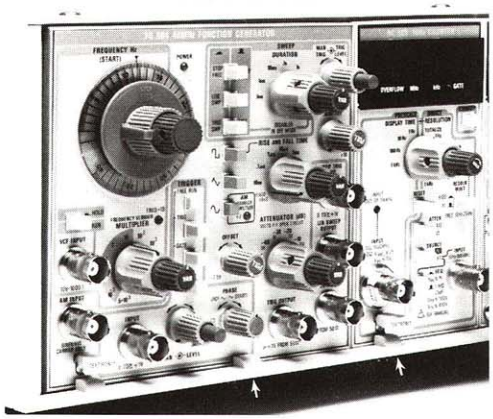
**Cabinet-to-Rackmount Conversion Kit** — Equipped with slide-out assembly, required to rackmount a TM 503 and a 603, 603A, 604, 604A, 605, 606, 606A, 607, 607A, 608, or 624 in a standard rack width. Order 040-0624-01 ..... **$120**

## MAINFRAMES DIMENSIONS AND WEIGHTS (WITHOUT PLUG-INS)

| | TM 501 | | TM 503 | | TM 504 | | TM 506 | | RTM 506 | | TM 515 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** | **mm** | **in** | **mm** | **in** | **mm** | **in** | **mm** | **in** |
| Width | 99 | 3.9 | 221 | 8.7 | 305 | 12.0 | 442 | 17.4 | 483 | 19.0 | 381 | 15.0 |
| Height | 152 | 6.0 | 152 | 6.0 | 152 | 6.0 | 152 | 6.0 | 133 | 5.3 | 173 | 6.8 |
| Depth | 389 | 15.3 | 432 | 17.0 | 508 | 20.0 | 508 | 20.0 | 480 | 18.9 | 508 | 20.0 |
| **Weight ≈** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** |
| Net | 2.4 | 5.4 | 4.3 | 9.5 | 8.4 | 18.5 | 13.2 | 29.0 | 14.4 | 32.0 | 10.2 | 22.5 |
| Shipping | 5.9 | 13.0 | 7.7 | 17.0 | 11.8 | 26.0 | 18.6 | 41.0 | 21.0 | 46.0 | 13.6 | 30.0 |
| Max Power Consumption*1 | 85 VA | | 250 VA | | 460 VA | | 670 VA | | 670 VA | | 500 VA | |

**1 Actual power consumption depends on plug-in selection and operating modes.*

### Mainframe Retainer Bar



The mainframe retainer bar modification kit comes complete with the retainer bar, all necessary parts and instructions.

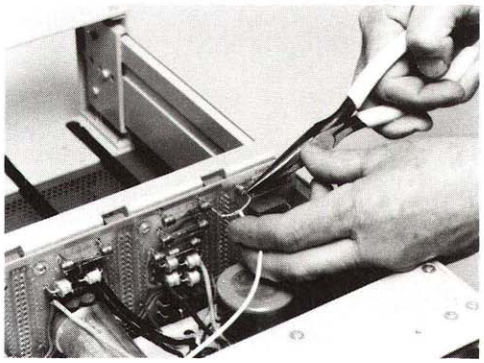
You may modify the TM 504 or RTM 506/TM 506 mainframe; each has a separate kit. Initial installation requires replacement of an existing bottom member of the mainframe with a new part supplied in the kit. Then, the retainer bar can be simply added or removed with four screws accessible from the bottom of the mainframe.

**ORDERING INFORMATION**

**TM 504** Mainframe Retainer Bar Kit
Order 020-0548-00 ..... **$45**

**TM 506/RTM 506** Mainframe Retainer Bar Kit.
Order 020-0549-00 ..... **$50**

### Mainframe Rear Interface



TM 500 and TM 5000 mainframes offer the unique ability to have separate modular instruments interconnected through the rear interface board of each mainframe. For example, the rear trigger output of a signal source can be interconnected to the rear input of a counter for instant frequency checks at the touch of a front-panel switch. Or, a digital multimeter and power supply may be interconnected to speed precise voltage set-ups without any need to move test leads. Any module can be internally connected through the mainframe and can also be externally interfaced out the back panel.

Most TM 500 and TM 5000 plug-in modules contain a duplication of the front panel input and output connections in the back. These interface lines are built into the rear-edge circuit card connector of each plug-in. Some modules also have additional signal or control lines which are present only at the back of the instrument. In either case, different modules may be interconnected by the user to reduce front panel clutter or to perform functions not otherwise available.

Mainframes can be interfaced a variety of ways. A user can solder together the appropriate connector pins on a standard mainframe, or can order the mainframe with the Option 02. The Option 02 version of the mainframe comes equipped with square pin connectors on the rear interface circuit board and a special wire kit consisting of standard wires and coaxial cables with mating square pin receptacles. Option 02 also provides a rear-panel male connector, mating cable connectors, and one BNC connector per plug-in compartment.

The square pin connectors eliminate the need to hand-solder connections to the interface circuit board, extending the life of the mainframes. The remaining Option 02 components offer a variety of interfacing alternatives limited only by the user's ingenuity and imagination.

The TM 515 mainframe is available with an Option 05 interface that includes everything in the Option 02 except for the rear panel male connector, mating cable connector and the BNC connectors.

Tektronix has published a Rear Interface Data Book that contains information on the interfacing capability of each instrument "family." This book is available through Tektronix by filling out a card included in each mainframe package.

Tektronix also makes a low-cost "do-it-yourself" Rear Interface Modification Kit. It enables those who don't need the full flexibility of factory installed interface pins at every connector to install a limited rear interface on any TM 500 and TM 5000 mainframe except the TM 501. The kit includes fourteen square pins, and three coaxial cables, all with female pin receptacles. Installation instructions also included. For "do-it-yourself" modification kit:

**ORDERING INFORMATION**

**Mainframe Rear Interface** Order 040-0846-01
..... **$55**

### Accessory Pouch

While the TM 501, TM 503, TM 504, and TM 506 TM 5003/TM 5006 mainframes were designed primarily for bench use, they are frequently carried away for service elsewhere. Taking along the probes, cables, terminators, and other accessories usually required can then be a problem. The soft vinyl accessory pouch neatly solves this problem; sturdy snap-around straps let the pouch be secured to the carrying handle of any TM 500/TM 5000 mainframe or Tektronix Oscilloscope, or the straps may be snapped together to form a carrying handle for the pouch to be used independently. A convenient side zipper lets accessory items be removed or stored without removing the pouch from the mainframe handle. Dimensions ≈9 1/4 in long x 5 3/4 in wide x 2 in high.

**ORDERING INFORMATION**

**Accessory Pouch** Order 016-0351-00
..... **$25**

### TM 500 Carrying Case

These luggage-type carrying cases for TM 500 equipment are molded of high strength glass-epoxy. The TM 503 model weighs 12 pounds empty and measures 23 1/2 inches long by 8 1/2 inches thick by 153 1/2 inches high, including rubber feet, lockable latches, and handle. Inside, the resilient polyurethane foam is molded to accept a TM 503 (with or without the protective front cover) plus either a spare TM 500 family module or a 200 Series miniscope. A third compartment in the foam accepts miscellaneous cables, accessories, or small tools.

The TM 504 case has a molded foam insert that will accept the TM 504 (with or without the protective front cover) but has no provisions for spare modules or tools. It is 610 mm long x 216 mm thick x 445 mm high, (24 in long by 8.5 in thick by 17.5 in high) and weighs ≈14 pounds empty.

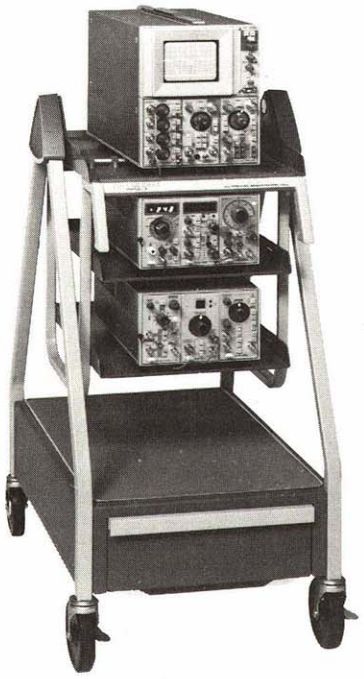
**ORDERING INFORMATION**

**TM 503 Carrying Case** Order 016-0565-00
..... **$395**

**TM 504 Carrying Case** Order 016-0608-00
..... **$425**

**TM 515 Carrying Case** Order 016-0643-00
..... **$450**

### Tek Lab Cart Model 3



*Model 3 shown with 436-0132-01 optional shelf.*

This Lab Cart is especially designed for a rollabout configuration combining TM 500/TM 5000 Instrumentation with the Tektronix oscilloscope of your choice. It features pistol-grip tilt control and a large accessory drawer in the base. The top tray accepts all TM 500/TM 5000 Series mainframes which accept up to four plug-in modules, or any Tektronix 7000 Series, 5000 Series, or portable oscilloscope. The Model 3 comes standard with one lower shelf. Additional shelves are available as optional accessories. The power distribution module on the rear underside of the top tray provides four power outlets and a 15 foot line cord.

International modification (Option 01) deletes power distribution module.

See page 431 for additional information.

**ORDERING INFORMATION**

**TEK Lab Cart Model 3** ..... **$595**
**Option 01** — Without Power Distribution Module ..... **NC**
**Additional Lower Shelf)** Order 436-0132-01 ..... **$45**
**Safety Belt** to secure oscilloscopes or TM 500/TM 5000 to top tray or lower shelves (not needed for 5000 Series or 7000 Series on top tray). Order 346-0136-01 ..... **$25**

### Protective Front Cover

A snap-on front cover, molded of high impact plastic, is available for the TM 503 (shown above), TM 504, and TM 506 mainframes. The cover adds 45 mm (1.75 in) to the length of the TM 503, TM 504, and TM 506 mainframes, and clears the longest knob projections on any of the instruments.

**ORDERING INFORMATION**

**TM 503** Front Panel Cover. Order 200-1566-00 ..... **$18**
**TM 504** Front Panel Cover. Order 200-1727-00 ..... **$17**
**TM 506** Front Panel Cover. Order 200-1728-00 ..... **$20**

### Rain Covers

These soft, weather-proof, vinyl-coated Rain Covers come in sizes for TM 503 and TM 504 instrumentation packages and include adequate space for protective front covers, as well. They feature heavy-duty zippers that open from either end, and include their own carrying handles, offset to compensate for the off-center balancing point of TM 500 instrumentation packages. The color is Tek blue.

**ORDERING INFORMATION**

**TM 504** Rain Cover. Order 016-0621-00 ..... **$45**
**TM 503** Rain Cover. Order 016-0620-00 ..... **$35**

### 1105 Battery Power Supply

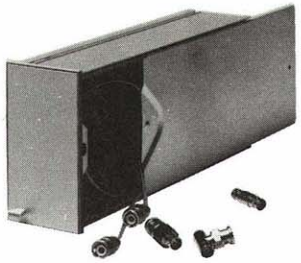
TM 500 instruments in their mainframes may be operated with the 1105 Battery Power Supply when suitable ac line power is not available. The 1105 is rugged and portable, operating on internal batteries or an external dc source. Operating time is dependent on the number and type of plug-ins being powered, and their operating mode. The following table shows estimated operating time for a full mainframe in a typical situation.

| | |
|---|---|
| TM 501 | 5.0 hours |
| TM 503 | 1.6 hours |
| TM 504 | 1.3 hours |
| TM 506 | 0.9 hours |
| TM 515 | 1 hour |

**ORDERING INFORMATION**

**1105** Battery Pack ..... **$1,550**
**Option 01** — 230 V Operation ..... **NC**

### Plug-in Storage Compartment



An electronic engineer or technician away from their bench seldom has enough storage space for probes, cables, "tees", accessories, and small tools. The plug-in storage compartment is a useful adjunct to many rollabout and Travel Lab configurations. If all five compartments in your TM 515 Traveler mainframe are not used for a particular field application, add a plug-in storage compartment for extra convenience. Even a rackmount TM 500 installation might profit by readily-available terminators or attenuators in a presently unused compartment. Compatible with all TM 500 mainframes and 5000 Series oscilloscope mainframes; inside dimensions 250 mm L x 51 mm W x 106 mm H, (9⅞ in L x 2 in W x 4¼ in H).

**ORDERING INFORMATION**

**Plug-in Storage Compartment** Order 016-0362-01 ..... **$125**

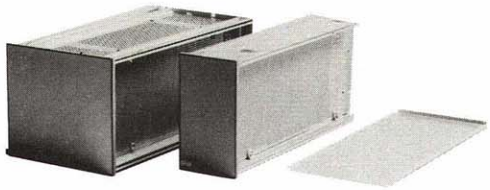
### TM 500/TM 5000 Blank Plug-in Panel

When operating 500/TM 5000 instruments with less than the full complement of plug-ins, the blank plug-in panel can be used to cover unused compartments.

**ORDERING INFORMATION**

**Blank Plug-in Panel** Order 016-0195-03 ..... **$25**

### TM 500 Custom Plug-in Kits



**Single and Double Compartment Sizes**
A complete test and measurement set-up for many typical jobs requires at least one nonstandard item. Such items commonly include relay circuits or manual switches for routing signals; test oscillators at pre-set frequencies for alignment purposes and markers; digital logic circuits for sequencing, timing, and control; special processors or converters such as log amps, multipliers, and analog-to-digital converters; and a variety of other system elements which are usually not available or economical as complete commercial instruments. The construction and packaging of these special items is always a problem, and the sheet metal work and provision for necessary power supplies often far exceeds the cost of the functional elements. This is why the TM 500 line includes custom plug-in kits. The kits provide perforated main circuit boards that allow rapid construction and wiring of circuits using both discrete components and integrated circuits. Also included are top and bottom rails, side cover, front sub-panel, and a blank dress panel, and the latch mechanism. An instruction sheet details the voltages and currents available in the power module. Standard voltage regulator ICs can be used to provide exact voltages for most individual power supply requirements. The finished special-purpose circuitry or instrument is physically compatible with other TM 500 instrumentation.

**Single Compartment with Power Supply**
A blank plug-in kit complete with power supply parts and circuit board layout is now available. A single-wide compartment, this plug-in kit saves set up and build time as the power supply circuitry is designed and kitted for you.

Specifically, the supplies parts are:

(1) A ground-referenced positive supply, capable of +7 V to +20 V at up to 400 mA. (Adjustment is centered at 15 V; change of resistor values required for total 7 V to 20 V range).

(2) A ground-referenced negative supply, identical to supply No. 1 except for polarity.

(3) A ground-referenced supply nominally 5 V, not adjustable, with current capability up to 1 ampere.

A series of TM 500 construction notes provide direction for building custom circuits using the TM 500 Blank Plug-in Kits and standard components. Among the construction notes available are: Suggested Power Supply Circuits and Thermal True RMS Converter:

**ORDERING INFORMATION**

**Custom Plug-in Kit** With Power Supply (Single Compartment). Order 040-0803-02 ..... **$115**

**Custom Plug-in Kit** Single Compartment. Order 040-0652-05 ..... **$95**

**Custom Plug-in Kit** Double Compartment. Order 040-0754-07 ..... **$125**

**Custom Plug-in Kit** Single Compartment Without ECB. Order 040-0821-03 ..... **$60**

# CURVE TRACERS

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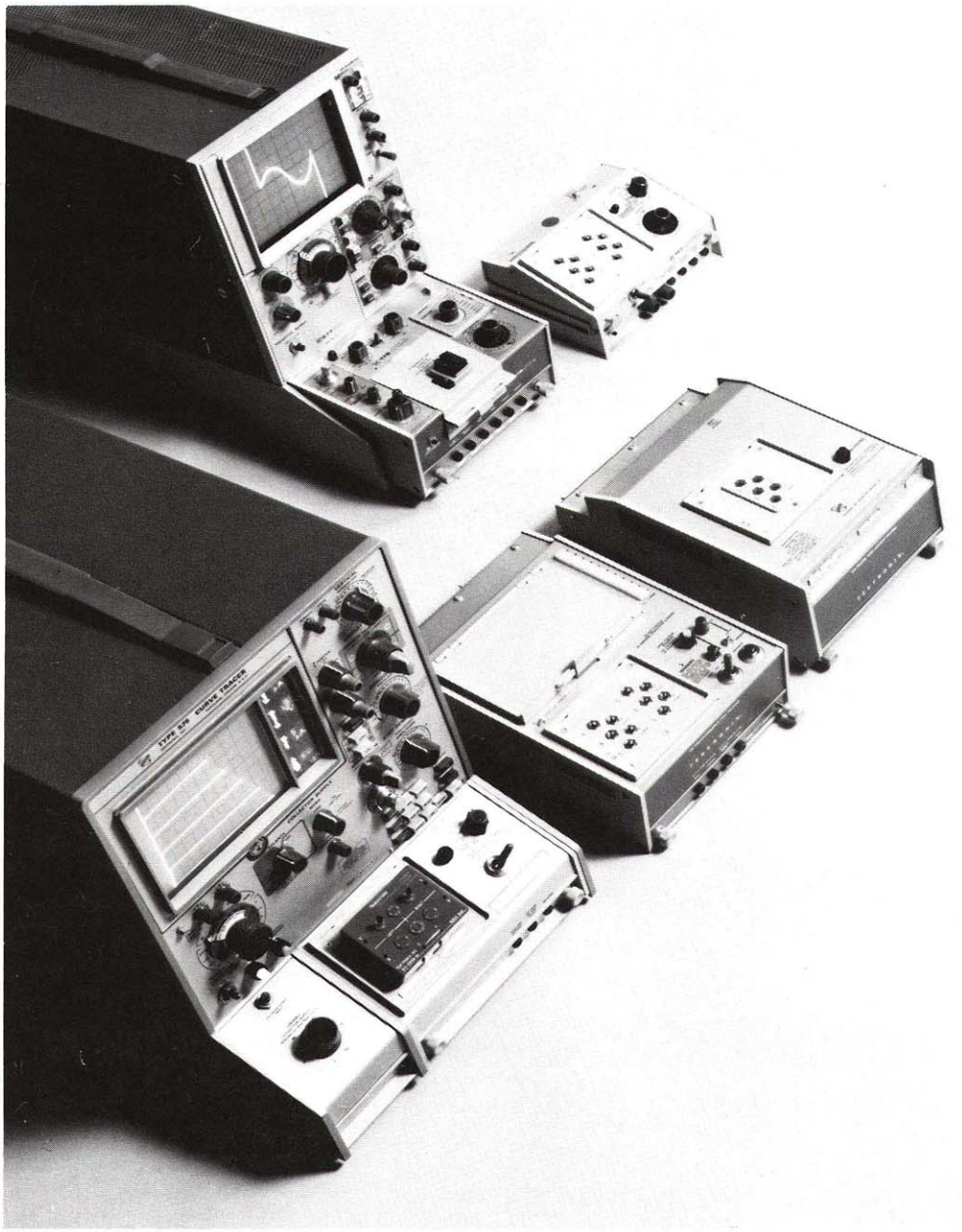


Curve Tracers can deliver comprehensive information about a multitude of semiconductor devices and integrated circuits, from two- and three-terminal devices through the full range of linear integrated circuits, from transistors and diodes to optoisolators, thyristors, and operational amplifiers.

These versatile measurement tools give you more than pinpointed parameters. A curve tracer can show you what happens between specified points in a quickly graphed curve, thus providing the valuable performance data necessary for accurate design, analysis, and evaluation.

If you are well acquainted with Curve Tracers, you will find the Curve Tracer System descriptions in this section helpful in choosing the system that best meets your requirements. If you would like to receive a brochure, application notes, and other materials to learn more about Curve Tracers and their measurement capabilities, please use the reply card; or, for faster action, contact a Tektronix Sales Engineer at the Sales Office nearest you.

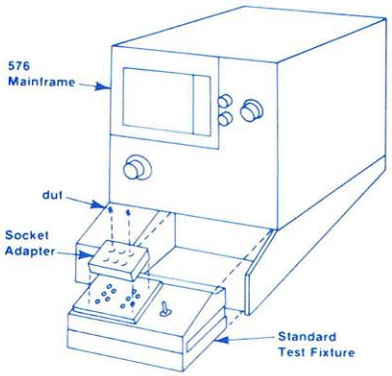
## 576

**Tests Two- and Three-Terminal Discrete Semiconductors**

**Power Capability Up to 220 W**

**Convenient Scale Factor Readout**

**Other Test Fixtures for Testing Power Devices and Semiautomated Testing**



The Tektronix 576 Curve Tracer System continues to hold the title "standard of the industry". The 576 accepts three different test fixtures: the Standard Test Fixture, 172 Programmable Test Fixture (see pabe 405), and the 176 Pulsed High-Current Fixture (see page 406). The 576 is an excellent general purpose curve tracer system that performs well in applications where high-current testing is required.

With the Standard Test Fixture, the collector supply of the 576 delivers up to 220 watts peak to the device under test. The step generator can deliver up to 2 amps in both its current and voltage modes of operation. With the 176 High-Current Fixture, the 576 is capable of pulsed collector operation up to 200 amps peak.

One of the features that sets the 576 apart from the Tektronix 577 Curve Tracer System is the display area adjacent to the 576's CRT. These alphanumeric indicators provide readout of vertical and horizontal deflection factors, step amplitude, and Beta/div or $g_m$/div. The Beta or $g_m$ readout saves the operator from the arithmetic usually necessary to arrive at these parameters. These indicators also provide a permanent record of major knob settings in 576 CRT photographs.

Another unique feature of the 576 is the Calibrated Display Offset. Combining a calibrated position control and a display magnifier, the Display Offset increases resolution and allows the operator to make more precise measurements.

Other features of the 576 Curve Tracer include: adjustable current limiting in the step generator, either 300 $\mu$s or 80 $\mu$s pulse width in pulsed base operation, pushbuttons to check display zero and calibration, and an illuminated graticule.

## CHARACTERISTICS

### COLLECTOR SUPPLY

**Modes**

Norm: Positive or negative full-wave rectified ac (line frequency); dc positive or negative.

Leakage: Emitter current rather than collector current measurements with an increase in the basic vertical deflection factor to 1 nA/div.

**Voltages*[1]**

| Range | 15 V | 75 V | 350 V | 1500 V |
|---|---|---|---|---|
| Max Continuous Peak Current | 10 A | 2 A | 0.5 A | 0.1 A |
| Peak Pulse Mode Current | ⩾20 A | ⩾4 A | ⩾1 A | ⩾0.2 A |

*[1] Peak open circuit voltages within +35% and −5% of indicated range.*

**Series Resistance** — From 0.3 Ω to 6.5 MΩ in 12 steps, all within 5% or 0.1 Ω. Peak Power Limit Setting: 0.1 W, 0.5 W, 2.2 W, 10 W, 50 W, 220 W.

**Safety Interlock** — Protects operator from 75 V, 350 V, and 1500 V collector voltages.

### STEP GENERATOR

**Current Mode** — Step/Offset Amplitude Range: 5 nA/mV/step (with X0.1 Mult) to 2 V/step, 1-2-5 sequence. Maximum Current (Steps and Aiding Offset): X20 Amplitude setting, except X10 (2 A) at 200 mA/step and X15 (1.5 A) at 100 mA/step. Maximum Voltage (Steps and Aiding Offset): At least 10 V. Maximum Opposing Offset Current: X10 Amplitude switch setting or 10 mA, whichever is less. Maximum opposing voltage is limited at 1 V to 3 V.

**Voltage Mode** — Step/Offset Amplitude Range: 5 mV/step (with X0.1 Mult) to 2 V/step, 1-2-5 sequence. Maximum Voltage (Steps and Aiding Offset): X20 Amplitude switch setting, 40 V maximum. Maximum Current (Steps and Aiding Offset): At least 2 A at 10 V, derating linearly to 10 mA at 40 V. Short Circuit Current Limiting: 20 mA, 100 mA, 500 mA +100%, −0%; 2 A +50%, −0%. Maximum Opposing Offset Voltage: X10 Amplitude switch setting. Maximum Opposing Current: Limited at 5 mA to 20 mA.

**Accuracy**

Incremental: Within 5%, between steps, within 10% with X1.0 Mult.

Absolute: Within 2% of total output including offset, or 1% of Amplitude setting, whichever is greater.

Offset Multiplier: 0 to X10 the Amplitude setting, continuously variable. Polarity Aid(s) or Oppose(s) the step polarity.

**Step Rates** — X0.5, X1 (Norm), and X2 the collector supply rate. The collector supply rate is twice line frequency.

**Pulsed Steps** — ≈80 μs or 300 μs width, at Norm or X0.5 rates.

**Offset Step/Offset Polarity** — The Step Gen polarity is the same as the Collector Supply polarity, and positive in the ac position. Step polarity may be inverted by actuating the Invert pushbutton.

**Step Family** — Repetitive or Single Family (manually actuated).

**Number of Steps** — Digitally selectable between one and ten.

### DEFLECTION CONTROLS

**Display Accuracies*[1]**

| | | OFFSET and MAGNIFIED with CENTERLINE VALUE from: | | |
|---|---|---|---|---|
| **NORM and Dc MODES** | **Normal** | **100-40 div** | **35-15 div** | **10-0 div** |
| Vert Collector Current | 3% | 2% | 3% | 4% |
| Horiz Collector Volts | 3% | 2% | 3% | 4% |
| Horiz Base Volts | 3% | 2% | 3% | 4% |
| **LEAKAGE MODE** Vert Emitter Current/div: | | NOT APPLICABLE | | |
| 10 nA-2 mA/div | 3% ± 1 nA | | | |
| 1 nA-200 μA/div (Magnified) | | 2% ± 1 nA | 3% ± 1 nA | 4% ± 1 nA |
| 5, 2, 1 nA/div | 5% ± 1 nA | NOT APPLICABLE | | |
| Horiz Collector or Base Volts with Emmitter Current/div of: | | | | |
| ⩾1 μA | 3% | 2% | 3% | 4% |
| 100, 10, or 1 nA | 3% plus 25 mV/ vert div | NOT APPLICABLE | | |
| 200, 20, or 2 nA | 3% plus 50 mV/ vert div | | | |
| 500, 50, or 5 nA | 3% plus 125 mV/ vert div | | | |
| **Vert Step Gen Position** | 4% | 3% | 4% | 5% |
| **Horiz Step Gen Position** | 4% | 3% | 4% | 5% |

*[1] With standard test fixture, shown as a percentage of highest on-screen value .*

**Vertical Deflection Factor** — Collector Current: 1 μA/div to 2 A/div, 20 steps in 1-2-5 sequence (0.1 μA/div with X10 magnification). Emitter Current: 1 nA/div to 2 mA/div, 20 steps in 1-2-5 sequence. Step Generator: 1 step/div.

**Horizontal Deflection Factor**

Collector Volts: 50 mV/div to 200 V/div 12 steps (5 mV/div with X10 magnification).

Base Volts: 50 mV/div to 2 V/div, 6 steps (5 mV/div with X10 magnification).

Step Generator: 1 step/div.

**Displayed Noise*[1]**

| Range | 15 V | 75 V | 350 V | 1500 V |
|---|---|---|---|---|
| Vertical — Collector | 1 μA | 1 μA | 2 μA | 5 μA |
| Vertical — Emitter | 1 nA | 1 nA | 1 nA | 5 nA |
| Horizontal — Base | 5 mV | 5 mV | 5 mV | 5 mV |
| Horizontal — Collector | 5 mV | 5 mV | 20 mV | 200 mV |

*[1] 1% or less, or the values shown.*

**Calibrator (Cal)** — Dc voltage (accurate within 1.5%) provided to check and adjust vertical and horizontal gain.

**Position Controls** — Fixed 5 div increments within 0.1 div. Continuous fine control over 5 div or less.

**Display Offset** — 21 calibrated positioning increments, vertically or horizontally, of 0.5 div or 5 div with X10 Magnifier.

### CRT AND READOUT

**CRT** — 165 mm (6.5 in) rectangular with parallax-free, illuminated graticule in centimeters. The calibrated area is 10 cm vertical by 10 cm horizontal (12 cm usable horizontal). GH (P31) Phosphor standard normally supplied.

**Readout** — The readouts, adjacent to CRT, are digital indicators of the following parameters: Per Vert Div from 1 nA/div to 2 A/div; Per Horiz Div from 5 mV/div to 200 V/div; Per Step from 5 nA/step to 2 A/step, 5 mV/step to 2 V/step; β (Beta) or $g_m$, Per Div from 1 μ to 500 k calculated from Current/Div, X10 Mag, Step Amplitude, and X0.1 Mult.

### STANDARD TEST FIXTURE (650-0459-01)

**Description** — A plug-in fixture wth two sets of five pin test terminals, the Emitter Grounded or Base Grounded switch, Left-Off-Right switch, Step Gen Output Ext Base or Emitter input and the Operator Protection Box. The test terminals accept either the six pin universal adaptors, three pin adaptors, or the high-power transistor adaptors with Kelvin contacts.

### POWER REQUIREMENTS

**Power Source** — Operates only with an unbalanced-to-ground power source. For safe operation, the power line neutral (white or "identified" conductor) must be connected to the instrument neutral (unfused), and the power plug safety ground (green conductor) must return to ground through a different path than the power line neutral.

**Voltage Ranges** — The quick-change line-voltage range selector accommodates 90 V ac to 136 V ac or 180 V ac to 272 V ac (six positions) at a line frequency of 48 Hz to 66 Hz.

**Maximum Power Consumption (Including DUT Power)** — 305 W. Standby Power: ≈60 W.

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Performance characteristics are valid over an ambient temperature range of +10°C to +40°C.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 292 | 11.5 |
| Height | 381 | 15.0 |
| Depth | 584 | 23.0 |
| **Weights** | **kg** | **lb** |
| Net | 32.0 | 70.5 |
| Shipping ≈ | 48.5 | 107.0 |

### INCLUDED ACCESSORIES

Standard test fixture (650-0459-01); transistor adaptor (013-0098-02); FET adaptor (013-0099-02); TO3 adaptor (013-0100-01); TO66 adaptor (013-0101-00); axial lead diode adaptor (013-0111-00); stud diode adaptor (013-0110-00); Kelvin sensors for large and small plastic transistors (013-0138-01); protective cover (337-1194-00); power cord; instruction manual.

## ORDERING INFORMATION

**576** Curve Tracer with Standard Test Fixture ..... **$11,455**

**The 576 Option 01** deletes the parameter readout module but maintains provisions for insertion of the module (020-0031-00) at any time. **Option 01** ..... **−$1,200**

**Auto Scale-Factor Readout Module** — Order 020-0031-00 ..... **$1,650**

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz

**Option A2** — UK 240 V/13 A, 50 Hz

**Option A3** — Australian 240 V/10 A, 50 Hz

**Option A4** — North American 240 V/15 A, 60 Hz

**Option A5** — Switzerland 220 V/10 A, 50 Hz

### OPTIONAL ACCESSORIES

**Test Setup Chart** — Package of 250. Order 070-0970-01 . **$10**

**172** — Test Fixture. (See page 405.) ..... **$4,815**

**176** — Test Fixture. (See page 406.) ..... **$5,435**

**Socket Adaptors** — (See page 411.)

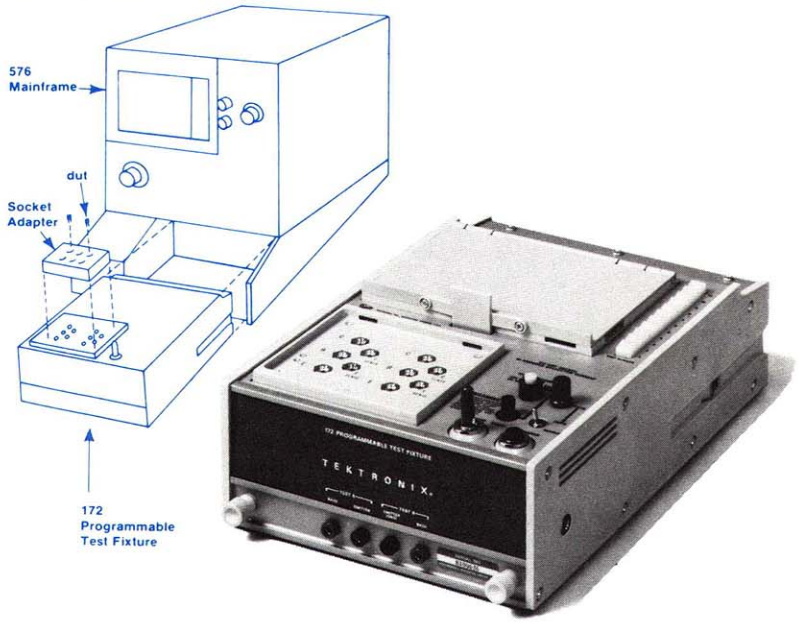
**Camera** — C-59A and adaptor. (See page 428.) ..... **$1,315**

# 172

**Semiautomated Test Fixture**

**Tests Up to 11 Parameters**

**Reduces Total Test Time**



The 172 Programmable Test Fixture, when used with the Tektronix 576 Curve Tracer, permits the operator to program a sequence of tests of FETs, transistors, and diodes.

The 172 can greatly reduce total test time in applications when more than one measurement is made on a batch of many devices. Without the 172, all devices in the batch must be repeatedly inserted in the test fixture, once for every measurement. However, the 172 Programmable Test Fixture performs as many as eleven different tests on each device.

The 172 sequences through the various tests either automatically or manually. A variable rate control is provided to set the test sequence at a rate which is best for the operator. New operators require more time per test, but with experience they will want to test at a faster rate. A front-panel switch or an optional foot switch advances the test in the manual mode.

## CHARACTERISTICS

### VERTICAL AND HORIZONTAL AMPLIFIERS

**Display Accuracies** — The same as the 576 Curve Tracer with its included Standard Test Fixture.

**Vertical Deflection Factor** — Tests 1 and 2 (Collector or Emitter Current): 1 μA to 2 A/div in 20 steps. Tests 3, 4, and 8, 9, 10, 11 (Collector or Breakdown Current): 1 μA to 0.5 A/div in 18 steps. Tests 5, 6, 7 (Leakage Current): 1 nA to 0.5 A/div in 27 steps. All steps are in a 1-2-5 sequence.

**Horizontal Deflection Factor** — Test 1: 0.05 V/div to 200 V/div in 12 steps. Test 2 (Base Voltage): 100 mV/div to 2 V/div in 5 steps. Input Z for Test 2: At least 100 MHz at 100 mV/div and 200 mV/div. 1 MΩ (within 2%) at 0.5 V/div, 1 V/div, and 2 V/div. Tests 3 and 4 (Collector Voltage): 100 mV/div to 2 V/div in 5 steps. Tests 5 through 11 (Breakdown or Leakage Voltage): 100 mV/div to 50 V/div in 9 steps. All steps are in a 1-2-5 sequence.

**Collector Sweep Voltage** — At least 2 V open circuit, or 1.5 A short circuit, at 100 mV/div and 200 mV/div. At least 5 V open circuit, or 2 A short circuit, at 500 mV/div. At least 20 V open circuit, or 150 mA short circuit, at 1 V/div and 2 V/div.

**Current Supply Accuracy** — 0.1 μA to 11 mA, accurate within 2% ±30 nA with up to 500 V compliance. 10 mA to 110 mA, accurate within 2% ±30 nA with up to 50 V compliance. Increments of current are: 0.1 μA (from 0.1 μA to 11 μA), 1 μA (from 10 μA to 110 μA), 10 μA (from 100 μA to 1.1 mA), 100 μA (from 1 mA to 11 mA) and 1 mA (from 10 mA to 110 mA).

**Voltage Supply Accuracy** — 1 V to 500 V, accurate within 3% ±300 mV with at least 0.5 mA compliance.

**Test Display Time Range (Automatic)** — 300 ms or less to at least 2 s continuously variable. Manual operation from a front-panel switch or optional foot switch.

| TESTS THAT CAN BE PERFORMED ON: | | | | PROGRAMMABLE CAPABILITIES |
|---|---|---|---|---|
| Test | Xstr | FETs | Diodes | |
| 1*1 | $H_{FE}$<br>$V_{CE(sat)}$ | $V_P$ | $V_F$ | Peak Current up to 10 A Peak Volts up to 350 V. |
| 2 | $V_{BE}$ | | | Horiz range is 100 mV/div to 2 V/div (other conditions same as Test 1). |
| 3 | $H_{FE}$,<br>$V_{CE(sat)}$ | $I_{DSS}$,<br>$R_{DS(on)}$ | | Base Drive: 100 nA to 110 mA. When testing FETs the base terminal is shorted to the emitter terminal.<br>Collector Sweep: three fixed ranges; 2 V, 5 V, and 20 V peak. Short circuit currents on these ranges are 1.5 A, 2 A, and 150 mA, respectively. |
| 4 | Same as #3 | | | |
| 5 | $I_{CEO}$ or $I_{CES}$,<br>$I_{CER}$ with external short or resistor | | | Voltage Supply: 1 V to 500 V dc. Leakage current measurements to 0.5 A.<br>The most sensitive deflection factor is 1 nA/div. |
| 6 | $I_{CBO}$ | $I_{GSS}$ | | Same as #5 |
| 7 | $I_{EBO}$ | | $I_R$ | Same as #5 |
| 8 | $V_{(BR)CEO}$ or<br>$V_{(BR)CER}$ with external resistor | | $V_F$ | Current Supply: 100 nA to 11 mA dc for breakdown voltage measurements to 500 V. Up to 110 mA dc for breakdown voltage measurements to 50 V. |
| 9 | $V_{(BR)CES}$ | $BV_{GSS}$ | | Same as #8. |
| 10 | $V_{(BR)CBO}$ | $BV_{GSS}$: | | Same as #8. |
| 11 | $V_{(BR)EBO}$ | | $V_R$ | Same as #8. |

**1 All of the test conditions for Test 1 are controlled by the 576 front-panel controls. Test 2 has the same conditions as Test 1 except the horizontal amplifier is connected to the emitter-base terminals, and the horizontal deflection factor is controlled by the programming card.*

*For the remaining test the only 576 controls that are functional are the Polarity and CRT controls such as Intensity, Focus, Display Offset.*

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Performance characteristics are valid over an ambient temperature range of +10°C to +40°C.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 200 | 7.9 |
| Height w/cover | 165 | 6.5 |
| Depth | 315 | 12.4 |
| **Weights** | **kg** | **lb** |
| Net | 5.2 | 11.5 |
| Shipping ≈ | 8.2 | 18.0 |

### INCLUDED ACCESSORIES

Protective cover (337-1194-00); five programming cards (016-0198-00); 250 programming card pins (214-1633-00); five CRT overlay limit cards (016-0510-00); instruction manual.

## ORDERING INFORMATION

**172** Programmable Test Fixture ..... **$4,815**

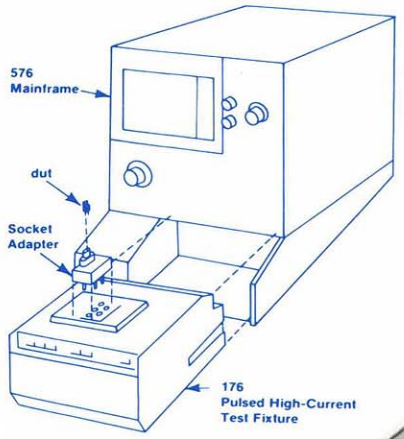
# TEK PULSED HIGH CURRENT CURVE TRACER FIXTURE

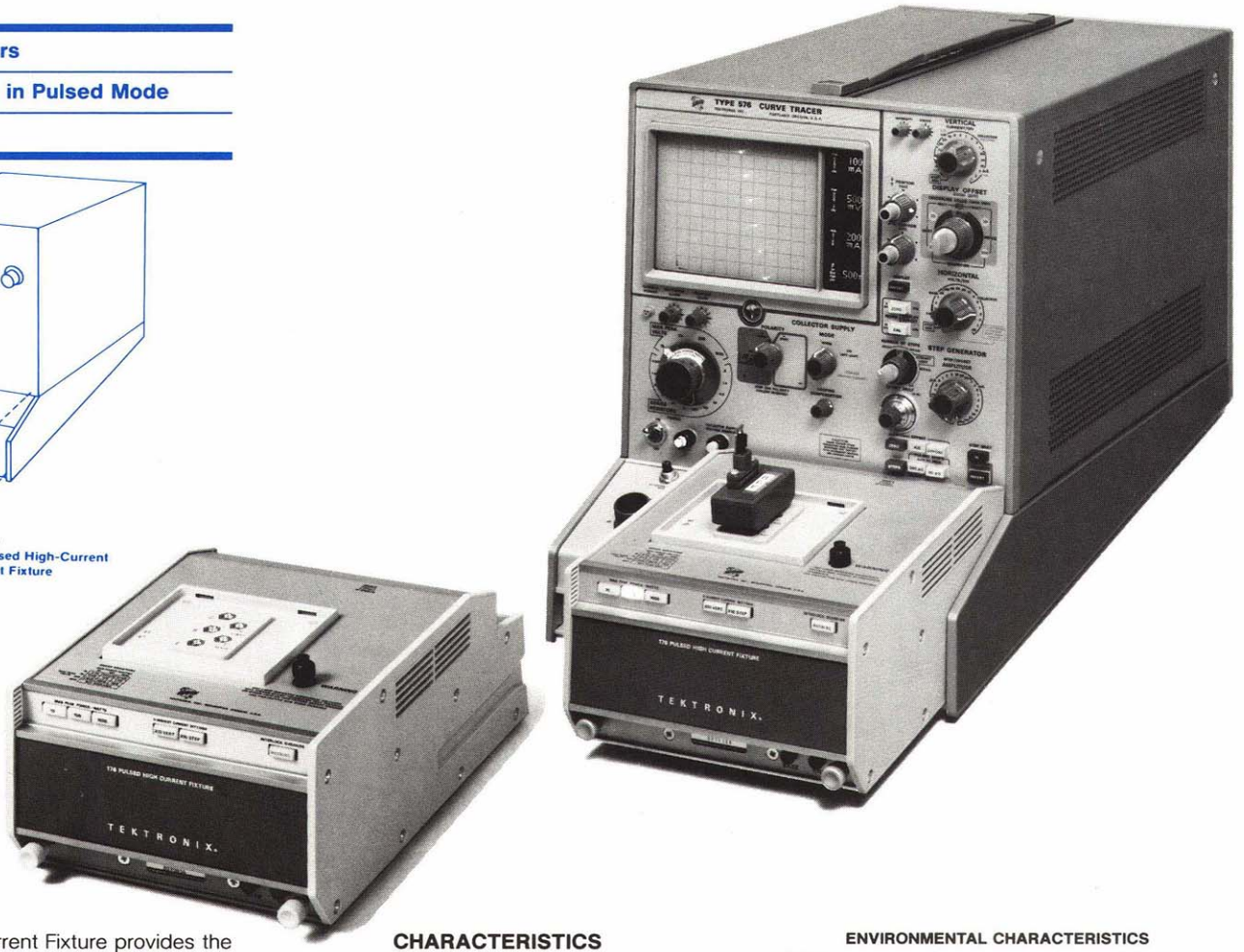
## 176

**Tests Power Transistors**

**Tests Up to 200 Amps in Pulsed Mode**

**1000 Watt Capability**




The 176 Pulsed High-Current Fixture provides the 576 Curve Tracer with pulsed collector operation to 200 amps peak and pulsed base steps to 20 amps peak. When selected, the step offset is also pulsed. The pulsed operating mode allows many tests previously considered impossible. For example, small signal transistors can be tested under pulsed collector breakdown conditions without overdissipation. The 176 Test Fixture fits in place of the 576 Standard Test Fixture. The collector pulse is slaved to the 576 in regard to width and repetition rate.

The pulse width is selected by pressing the 300 μs or 80 μs pushbutton on the 576 mainframe (usually, 300 μs should be selected). The repetition rate is automatically set when the 176 is inserted in the mainframe. Repetition rate is also dependent on power-line frequency. The five highest Vertical Current/Div settings (0.1 A/div to 2 A/div) of the 576 can be multiplied X10 by actuation of the X10 Vert pushbutton on the 176. This feature enables viewing of up to a 200 amp peak display. The five highest Step Generator Amplitude base current steps of the 576 (10 mA to 200 mA) can be multiplied X10 by actuation of the X10 Step pushbutton on the 176. This feature enables the pulsed base step generator on the 176 to provide up to a 20 amp base step (tenth step). Both X10 Vert and X10 Step pushbuttons provide inputs to the fiberoptic readout in the 576 to display actual values.

## CHARACTERISTICS

### COLLECTOR SUPPLY (PULSED)

**Width** — 300 μs or 80 μs determined by 576.
**Repetition Rate** — Power-line frequency.
**Polarity** — + or − determined by 576 polarity control.
**Amplitude** — Ranges are 15 V, 75 V, 350 V nominal, controlled by Max Peak Volts switch on 576. Current (minimum available at low line into shorted load) is 15 V range, 200 A; 75 V range, 40 A; 350 V range, 8 A.
**Maximum Peak Watts** — Three illuminated pushbuttons select 10 W, 100 W, 1000 W maximum peak power.

### STEP GENERATOR

**Current Ranges (X10 Step Selected)** — Step-Offset Amplitude Range: 100 mA to 2 A, 5 steps in a 1-2-5 sequence. Maximum Current (Steps and Aiding Offset): 200 x 576 Amplitude setting or 20 A, whichever is less. Maximum Voltage (Steps and Aiding Offset): At least 5 V up to 10 A and 2 V up to 20 A.
**576 Offset Multiplier** — 0 to 100 x 576 Amplitude switch setting.
**Step Rate** — Power-line frequency.
**Pulsed Steps** — 300 μs or 80 μs wide.
**Step/Offset Polarity** — The Step Gen polarity is the same as the Collector Supply polarity. Step polarity may be inverted by actuating the Invert pushbutton.
**Accuracy (Current Steps Including Offset)** — Incremental: Within 5% between any two steps; within 10% with X0.1 Step Mult. Absolute: Within 3% of total output ±1% of one step or within 3% of one step, whichever is greater.

### VERTICAL AMPLIFIER

**Deflection Factor (X10 Vert Selected)** — 1 A/div to 20 A/div, 5 steps in a 1-2-5 sequence.

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Performance characteristics are valid over a temperature range of 0°C to +40°C.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 200 | 7.9 |
| Height | 117 | 4.6 |
| Depth | 290 | 11.4 |
| **Weights** | **kg** | **lb** |
| Net | 5.8 | 12.8 |
| Shipping ≈ | 8.2 | 18.0 |

### INCLUDED ACCESSORIES

TO36 adaptor (013-0112-00); stud diode adaptor (013-0110-00); protective shield (337-1194-00); instruction manual.

## ORDERING INFORMATION

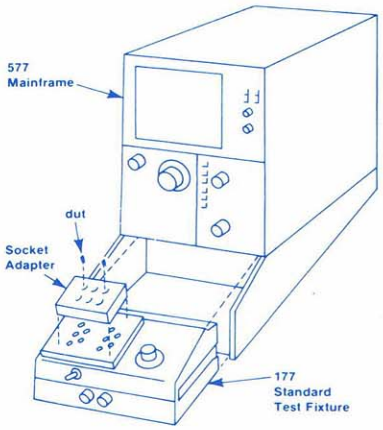
**176** Pulsed High-Current Fixture ..... **$5,435**

## 577

**Test Two--Terminal and Three-Terminal Discrete Semiconductors**

**Storage Capability**

**Power Capability Up to 100 W**



The 577 Curve Tracer System, when used with the 177 Standard Test Fixture, is a smaller and lighter configuration that retains many of the important features and performance of the 576. The 577 also accepts the 178 Linear IC Test Fixture. The major features that separate the 577 from the 576 are a storage CRT (optional) and the emphasis on low current measurements with the 577.

The 577's storage CRT may be used to overlay the characteristic curves of one device on top of the stored characteristics of another. Dot displays (generated during high current pulsed testing or during very low current testing under dc conditions) can be transformed into complete characteristic curves by simply moving them across the CRT while in the storage mode. A good example of a dot display occurs in op amp testing because the open-loop, 3 dB bandwidth of many op amps is so low that the curves must be plotted slowly. Linear ICs such as op amps may be tested with the 577 by using the 178 Linear IC Test Fixture (see page 409).

In the 577/177 Curve Tracer System, several features facilitate low current measurements. They include: small current sensing resistors (which result in less capacitive looping), current sensing that always takes place in the collector supply lead (which permits measurements on three-terminal active devices at the lowest current ranges and eliminates the need for a correction to the horizontal deflection factor), and a display filter (which reduces vertical deflection noise).

Although the 577/177 Collector Supply has lower power capability (the 576 can deliver approximately 2.2 times as much power to the device under test), approximately the same test current is available; 10 amps continuous peaks at line frequency. The 577/177 provides its highest currents at a lower voltage than does the 576.

Other innovations in the 577/177 Curve Tracer are an emitter-base breakdown position on the lead selector switch, availability of approximately 95 steps from the step generator, an uncalibrated bias supply, independent magnifiers that increase resolution on either or both CRT axes, and a beam finder.

## CHARACTERISTICS

All characteristics are for the 577 Curve Tracer Mainframe operating with a 177 Standard Test Fixture.

### COLLECTOR SUPPLY

**Modes** — Five modes of collector supply operation are selectable. These are: ac at line frequency, positive full wave rectified, negative full wave rectified, positive dc, or negative dc.

**Voltage*[1]**

| Max Peak Volts Open Circuit | 6.5 V | 25 V | 100 V | 400 V | 1600 V |
|---|---|---|---|---|---|
| Continuous Current, Peak | 10 A | 2.5 A | 0.6 A | 0.15 A | 0.04 A |
| Peak Pulse Current | 20 A | 5 A | 1.25 A | 0.30 A | 0.08 A |

*[1] The voltage is variable to the maximum peak volts selected.*

**Series Resistance** — 14 values from 0.12 Ω to 8 MΩ. Coupling of series resistance and voltage controls maintains maximum peak power to the device under test when changing voltage ranges.

**Safety Interlock** — Protects operator from 100 V, 400 V, and 1600 V ranges. Momentary button provides for overriding interlock.

### STEP GENERATOR

**Current Mode** — Step Amplitude Range: 5 nA/step (with Step X0.1) to 200 mA/step, in a 1-2-5 sequence. Available Current: At least 2 A on the highest amplitude setting with 5 V or more compliance. For opposing offset, available current is at least 10 mA with voltage limited between 1 V and 5 V.

**Voltage Mode** — Step Amplitude Range: 5 mV/step (with Step X0.1) to 2 V/step, in a 1-2-5 sequence. Current: Limited between 100 mA and 200 mA. For opposing offset, available current is at least 10 mA (at 0 V) derating to 0 mA at 20 V.

**Accuracy** — Incremental: Within 2% between steps. Absolute: Within 3% of total output or Amplitude setting, whichever is greater. When Step X0.1 is actuated the absolute step accuracy is 4%.

**Step Rate** — Selectable at X1 (Slow), X2 (Norm), or X4 (Fast) line frequency.

**Pulsed Steps** — Steps can be gated for a duration of ≈300 μs for testing at low duty cycle.

**Step/Offset Polarity** — With Norm Polarity selected, the Step Generator polarity is the same as the Collector Supply polarity, and positive in the ac position. Polarity can be independently inverted with Step/Offset Polarity control or from the test fixture.

**Offset** — The amplitude of the entire set of steps can be offset in a continuously variable and calibrated manner to either Aid or Oppose steps. Maximum range of offset is 10 full-amplitude steps.

**Step Family** — Repetitive or single family.

**Number of Steps** — Selectable from 1 to 10 full-amplitude steps. Selectable up to ≈95 steps when using Step X0.1 multiplier.

### DEFLECTION CONTROLS

**Display Accuracies*[1]**

| Display Mode | Normal | Magnified |
|---|---|---|
| Vertical Collector Current | 3% ± 1 nA | 4% ± 1 nA |
| Horizontal Collector Volts | 3% | 4% |
| Horizontal Base Volts | 3% | 4% |
| Horizontal Step Gen | 4% | 5% |

*[1] As a percentage of highest on-screen value.*

**Vertical Deflection Factor** — Collector Current: 2 nA/div to 2 A/div, 28 steps in 1-2-5 sequence (0.2 nA/div to 0.2 A/div with X10 magnification).

**Horizontal Deflection Factor**

Collector Volts: 50 mV/div to 200 V/div, 12 steps in a 1-2-5 sequence (5 mV/div to 20 V div with X10 magnification).

Base Volts: −50 mV/div to 2 V/div, 6 steps in a 1-2-5 sequence (5 mV/div to 0.2 V/div with X10 magnification).

Step Generator: 1 step/div (0.1 step/div with X10 magnification).

**Automatic Scale Factor Readout** — Change in deflection factor is indicated by lights behind the knob skirt when using X10 Mag.

**Automatic Positioning** — Trace (or spot) is automatically positioned when Collector Supply polarity is changed when using the 177.

**Display Invert** — Single control inverts display and repositions trace.

**Display Filter** — Selectable low pass filter reduces vertical noise for easier high sensitivity measurements.

### CRT

**CRT** — Rectangular 165 mm (6.5 in) with an 8 x 10 division (1.27 cm/div) parallax-free internal graticule. Two display modules are available for the 577. The D1 display unit has a split-screen storage CRT with phosphor similar to GJ (P1). The D2 display unit has a nonstorage CRT with GH (P31) Phosphor standard. Accelerating potential is 3.5 kV.

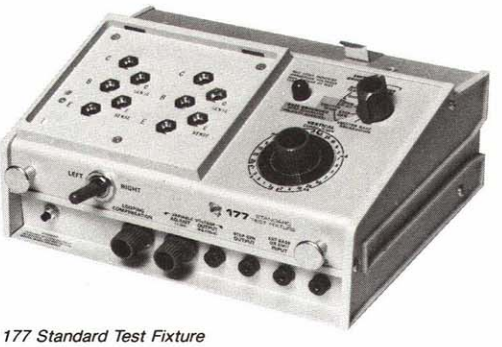
**Beam Finder** — Compresses off-screen trace to within graticule area.

**Ambient Temperature Range** — Performance characteristics are valid over an ambient temperature range of +10°C to +40°C.

### PHYSICAL CHARACTERISTICS

| | 577 | | 177 | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 224 | 8.8 | 201 | 7.9 |
| Height | 503 | 19.8 | 102 | 4.0 |
| Depth | 584 | 23.0 | 152 | 6.0 |
| **Weights** | **kg** | **lb** | **kg** | **lb** |
| Net | 18.1 | 40.0 | 1.1 | 2.5 |
| Shipping ≈ | 22.7 | 50.0 | 2.7 | 6.0 |

Note: When the 577 and 177 are ordered together their combined shipping weight is: domestic ≈24 kg or ≈53 lb.



*177 Standard Test Fixture*

## CHARACTERISTICS

**Device Lead Selection** — Switch provides six different lead configurations. Three positions for Emitter Grounded measurements provide Step Gen, Open (or Ext), and Short base terminal connections. Two positions for Base Grounded measurements provide Step Gen and Open (or Ext) emitter terminal connections. One position provides for Emitter Base Breakdown or leakage measurements up to 25 Vs.

**Left-Right Switch** — Selects left or right test connections. Off in center position. Test connection area accepts all Tektronix Curve Tracer adaptors and protective cover. Kelvin connections are provided for emitter and collector terminals.

**Looping Compensation** — Reduces display loops due to test adaptor capacitance and some device capacitance.

**Variable Voltage Supply** — Continuously variable bias supply from −12 V to +12 V. Source resistance is 10 kΩ or less.

### POWER REQUIREMENTS

**Line Voltage Ranges (±10%)** — 100 V ac, 110 V ac, 120 V ac or 200 V ac, 220 V ac, 240 V ac.

**Line Frequency** — 50 Hz to 60 Hz.

**Power** — 155 W max at 110 V ac, 60 Hz.

### INCLUDED ACCESSORIES

Transistor adaptor for most bipolar transistors and some MOS FETs (013-0098-02); axial lead diode adaptor with Kelvin sensing terminals (013-0111-00); protective shield for test connection area (337-1194-00); instruction manual.

## ORDERING INFORMATION

**577/D1** Storage Curve Tracer Mainframe (w/o Test Fixture) ..... **$6,375**

**577/D2** Nonstorage Curve Tracer Mainframe (w/o Test Fixture) ..... **$5,505**

**Option 10** — 10 x 10 cm graticule; available with either storage or nonstorage mainframe ..... **+$50**

**177** Standard Test Fixture ..... **$1,310**

### OPTIONAL ACCESSORIES

**178** — Linear Test Fixture. (See page 409.) ..... **$3,280**

**Test Setup Chart** — Package of 250.
Order 070-1639-00 ..... **$7.50**

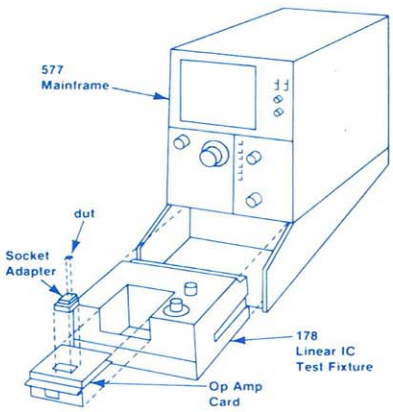
**Device Adaptor Sockets** — (See page 411.)

**C-5C** — Camera ..... **$495**

**Model 3 Tek Lab Cart** ..... **$595**

# 178

**Tests Single, Dual, or Quad:**
**Operational Amplifiers, Comparators**
**Differential Amplifiers, Regulators and More**




Since linear ICs are typically tested under very low current conditions, the 577/178 Curve Tracer System is ideally suited to the task. The 178 Linear IC Test Fixture provides the necessary and accurate low-current measurement capability. Test cards set up the measurement function, and the 577's storage CRT allows the operator to transform the dot display (usually seen under low current dc conditions) into a complete characteristic curve by slowly sweeping the dot across the CRT while in the Storage Mode.

A 577/178 Curve Tracer System is composed of a 577 mainframe, 178 Linear IC Test Fixture, appropriate test cards (choose from three op amp cards and two regulator cards), and the proper socket adaptor that interfaces the system to the device under test.

Test cards, which slide into the 178, define the measurement function of the 178 Test Fixture. Two families of test cards are available: op amp cards and regulator cards. Op amp cards are used for testing standard and special op amps, comparators, differential amplifiers, video amplifiers, etc. Regulator cards are used for testing positive and negative three-terminal voltage regulators.

### OP AMP CARDS

The Standard Op Amp Card is designed to test devices that require single or dual power supplies, have two (differential) high-impedance inputs, and a single output. Common measurements include: offset voltage, positive and negative input current, CMRR, gain, positive and negative psrr, positive and negative supply current, and collector supply current.

The Hardwire Card is designed for those applications where there is an advantage in preparing individual cards for specific devices so that they may be quickly switched to accommodate a change in the type of device under test. The Hardwire Card also offers a greater degree of freedom to the knowledgeable designer in testing special devices.

The Multiple Op Amp Card allows the operator to test up to four devices in a single package by simply operating a four-position switch. The four-position switch selects the op amp (in a multiple op amp package) or the selection of a linear IC to be tested. The measurements performed are the same as those available with the Standard Op Amp Card.

### Socket Adaptors for Op Amp Cards

The device under test socket on the Standard and Multiple Op Amp Cards accepts several types of socket adaptors using the Amphenol-Barnes Adaptor System. This system accepts most of the standard package configurations (TO5, DIP, flat pack, etc). Sockets for these cards are shown on the last page of this section.

### REGULATOR CARDS

There are two types of Regulator Cards, positive and negative. These cards are used primarily in measuring parameters of three-terminal voltage regulators. Parameters measured include: output voltage, load regulation, line regulation and ripple regulation, and quiescent and common terminal current.

### Socket Adaptors for Regulator Cards

Socket adaptors for both positive and negative three-terminal regulators are the same as the Kelvin Sensing Adaptors used on the standard curve tracer. (See the last page of this section.)

### CHARACTERISTICS

| Vertical Deflection*1 | Normal | Magnified |
|---|---|---|
| Input Voltage or ΔInput Voltage | 10 μV/div to 50 mV/div | 1 μV/div to 5 mV/div |
| Accuracy*2 | 3% | 4% |
| Input Current | 50 pA/div to 0.2 mA/div | 5 pA/div to 20 μA/div |
| Accuracy*2 | 3% ±50 pA | 4% ±50 pA |
| Power Supply Current | 0.1 μA/div to 50 mA/div | 10 nA/div to 5 mA/div |
| Accuracy*2 | 3% ±0.1 μA | 4% ±0.1 μA |
| Collector Supply Current | 1 nA/div to 50 mA/div | 0.1 nA/div to 5 mA/div |
| Accuracy*2 | 3% ±1 nA | 4% ±1 nA |

*1 1-2-5 sequence.
*2 Percentage of highest on-screen values.

**Power Supplies** — Positive and negative supplies are adjustable from 0 V to 30 V; available current is at least 150 mA with adjustable current limiting. The voltage of both supplies can be adjusted from a single calibrated control; accuracy is within 2% ±100 mV. Negative supply can be independently adjusted by an uncalibrated control.

**Sweep Generator** — A sinusoidal signal controls the output, common-mode input, or the power supply voltages of the device under test. Frequency: Adjustable from 0.01 Hz to 1 kHz. Amplitude: Adjustable up to 30 V peak.

**Source Resistance** — For input resistor pairs, selectable 50 Ω 10 kΩ, 20 kΩ, and 50 kΩ, or external resistors may be used. When the vertical deflection factor is in one of the less sensitive positions, 1 mV through 50 mV/div, the input resistance values are 550 Ω greater.

**Load Resistance** — Six selectable load resistors, 100 Ω, 1 kΩ, 2 kΩ, 5 kΩ, 10 kΩ, 20 kΩ, and 50 kΩ, or external resistors may be used.

**Collector Supply** — The 25 V and 100 V ranges of the collector supply (located on 577 mainframe) are available to the 178 Test Fixture. Supply output is located on the 178 front-end panel and on the device card. Automatic positioning with supply polarity is inoperative when using the 178 Test Fixture. (See 577/177 characteristics for collector supply performance.)

**Step Generator** — All the capabilities of the step generator (located on 577 mainframe) are available to the 178 Test Fixture. Generator output is located on the 178 front-end panel and on the device card. (See 577/177 characteristics for step generator performance.)

**DUT Supplies Disconnect** — A single switch disconnects all power to the device under test; both plus and minus power supplies, collector supply, and step generator.

**Function Switch** — Selects vertical and horizontal deflection signals and connection of the test signal to the device under test.

**Zero** — Single pushbutton provides a zero reference to the CRT display and in certain functions, nulls out offset voltage in order to measure Δinput V on the vertical display axis.

### THREE-TERMINAL REGULATOR TEST CARD CHARACTERISTICS

**Device Under Test Input Supply**

Input Voltage: Two ranges 0 V to 30 V and 0 V to 60 V. 0 V to 30 V: Within ±2% ±200 mV of dial setting. 0 V to 60 V: Within ±2.5% ±300 mV of dial setting.

Regulation — Within 200 mV.

Input Sweep Frequency — Dc to 1 kHz.

300 μs Pulsed Current — 5 mA to 2 A.

**Short Duration Dc Current*1**

| Supply Voltage | Current |
|---|---|
| 0 to 10 | 700 mA |
| 10 to 20 | 350 mA |
| 20 to 40 | 350 mA |
| 40 to 60 | 120 mA |

*1 One minute duration.

**Device Under Test Current Load** — 5 mA to 2 A within ±3% of 0 mA to 1.25 mA.

**Device Under Test Comparison Output Dc Voltage Accuracy** — 0 V to 10 V range within ±1% ±20 mV. 0 V to 100 V range within ±1% ±150 mV.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 201 | 7.9 |
| Height | 114 | 4.5 |
| Depth | 198 | 7.8 |
| **Weights** | **kg** | **lb** |
| Net | 1.5 | 3.3 |
| Shipping ≈ | 3.6 | 8.0 |

### INCLUDED ACCESSORIES

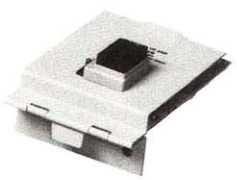
16 DIP IC sockets (136-0442-00); standard Op Amp Card with cover and ten patch cords (013-0149-02); interchangeable nomenclature panel for function switch (333-1770-00); instruction manual.

### ORDERING INFORMATION

**178** Linear IC Test Fixture ..... **$3,280**

### OPTIONAL ACCESSORIES

**Standard Op Amp Card** — One included with 178. Order 013-0149-02 ..... **$165**
**Hardwire Card** — Order 013-0150-02 ..... **$110**
**Multiple Op Amp Card** — Order 013-0155-01 ..... **$580**
**Positive Regulator Card** — Order 013-0147-00 ..... **$995**
**Negative Regulator Card** — Order 013-0148-00 ..... **$995**



*Standard Op Amp Card*

*Positive Regulator Card*

## 5CT1N/7CT1N

**Tests Semiconductor Devices to 0.5 W**

**10 nA/div to 20 mA/div Vertical Deflection Factors**

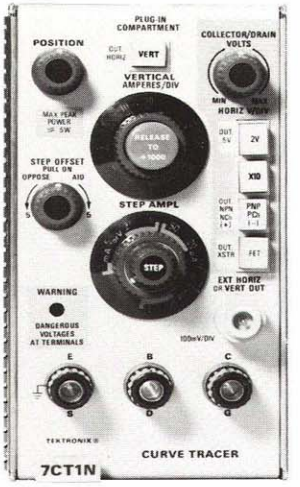
**0.5 V/div to 20 V/div Horizontal Deflection Factors**

**Easy to Operate**

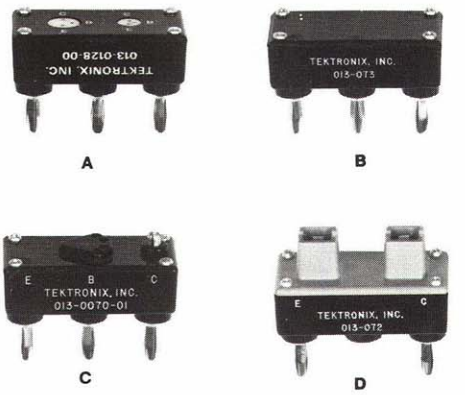
5CT1N

Curve Tracer

7CT1N




Curve Tracer




The 7CT1N Curve Tracer is a plug-in unit for use in Tektronix 7000 Series oscilloscope systems and the 5CT1N Curve Tracer is a plug-in unit for use in Tektronix 5000 Series oscilloscope systems. Both are for displaying characteristic curves of small-signal semiconductor devices to power levels up to 0.5 watts. The plug-ins operate in a vertical compartment of the respective mainframes. The 7CT1N also operates in the horizontal compartments of the 7000 Series oscilloscope systems.

### CHARACTERISTICS

**COLLECTOR/DRAIN SUPPLY**

| | X1 | | X10 | |
|---|---|---|---|---|
| Horizontal Volts/Div | 0.5 | 2 | 5 | 20 |
| Voltage Range | 0 - 7.5 V | 0 - 30 V | 0 - 75 V | 0 - 300 V |
| Maximum Current | 240 mA | 60 mA | 24 mA | 6 mA |

**Maximum Open Circuit Voltage** — Within ±20%. Maximum short circuit current within 30%.

**Series Resistance** — Automatically selected with horizontal V/div switches. Peak Power: 0.5 W or less depending upon control settings.

**High Voltage Warning** — When the horizontal V/div switch is in the X10 position, a flashing warning light appears on the front panel indicating that dangerous voltages may exist at the test terminals.

**STEP GENERATOR**

**Transistor Mode** — Step Amplitude Range: 1 μA/step to 1 mA/step, 1-2-5 sequence. Maximum Current (Steps Plus Aiding Offset): X15 amplitude setting. Maximum Voltage (Steps Plus Aiding Offset): At least 13 V. Maximum Opposing Offset Current: At least X5 amplitude setting.

**FET Mode** — Step Amplitude Range: 1 mV/step to 1 V/step, 1-2-5 sequence. Voltage Amplitude (Steps Plus Aiding Offset): X15 amplitude setting, 13 V maximum. Source Impedance: 1 kΩ ± 1%.

**Accuracy**

Incremental: Within 3% between steps.

Absolute: Within ±(3% + X0.3 amplitude setting).

**Step Polarity** — The step generator polarity is the same as the collector/drain supply in the transistor mode and opposing in the FET mode.

**Number of Steps** — Selectable in one-step increments between 0 and 10.

**Offset** — Selectable from 0 to 5 steps. Polarity aids or opposes the step polarity.

**Vertical Deflection Factors** — 10 nA/div to 20 μA/div with the ÷1000 control activated. 10 μA/div to 20 mA/div in the X1 mode.

**Vertical Display Accuracy** — Within 5% in the X1 mode. Within 5% ±0.2 nA per displayed horizontal V when in the ÷1000 mode.

**Horizontal Deflection Factors** — Selectable, 0.5 V, 2 V, 5 V, or 20 V.

**5CT1N Horizontal Display Accuracy** — Within 5% plus the deflection factor accuracy of the plug-in being driven. The plug-in would be a vertical or horizontal amplifier (such as the Tektronix 5000 Series plug-ins) with a 50 mV/div deflection factor and an input R of at least 50 kΩ and would be used in the horizontal compartment of a 5000 Series oscilloscope mainframe.

**7CT1N Horizontal Display Accuracy** — Within 5% plus the deflection factor accuracy of the plug-in being driven. The plug-in would be a vertical or horizontal amplifier (such as the Tektronix 7000 Series plug-ins) with a 100 mV/div deflection factor and an input R of at least 50 kΩ and would be used in the horizontal compartment of a 7000 Series oscilloscope mainframe.

**ENVIRONMENTAL CHARACTERISTICS**

**Ambient Temperature** — Performance characteristics are valid from 0°C to +50°C.

**PHYSICAL CHARACTERISTICS**

| | 5CT1N | | 7CT1N | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 66 | 2.6 | 71 | 2.8 |
| Height | 127 | 5.0 | 127 | 5.0 |
| Depth | 305 | 12.0 | 368 | 14.5 |
| **Weights** | **kg** | **lb** | **kg** | **lb** |
| Net | 0.8 | 1.8 | 1.1 | 2.5 |
| Shipping ≈ | 1.8 | 4.0 | 2.7 | 6.0 |

**INCLUDED ACCESSORIES**

Test adaptor with two sets of test terminals, one with TO5 basing and the other with TO18 basing (013-0128-00); instruction manual.

### ORDERING INFORMATION

**5CT1N** Curve Tracer ..... **$995**

**7CT1N** Curve Tracer ..... **$1,550**

### 3-PIN ADAPTORS

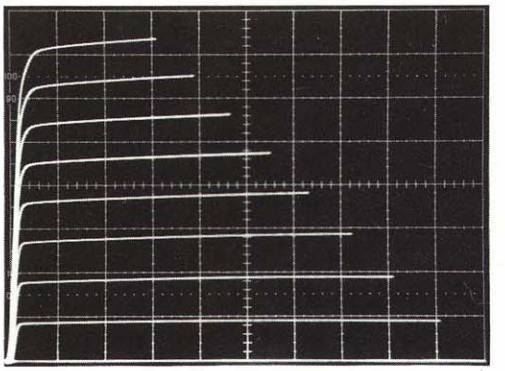
The following 3-pin adaptors may be used with any of the Tektronix curve tracer products. They do not have Kelvin sensing contacts.

**A. TO5 or TO18** — Transistor Adaptor. Order 013-0128-00 ..... **$40**

**B. Blank Adaptor** — For mounting special sockets. Order 013-0073-00 ..... **$19**

**C. TO3 or TO66** — Transistor Adaptor. Order 013-0070-01 ..... **$44**

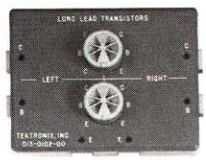
**D. Diode Test Adaptor** — Holds axial-lead diodes. Order 013-0072-00 ..... **$92**



*2N3904 transistor characteristic generated by the 7CTIN. Control Settings are indicated on front panel of 7CTIN.*
*Vertical: 2 mA/div.*
*Horizontal: 0.5 V/div.*
*Base Current: 10 μA/step.*

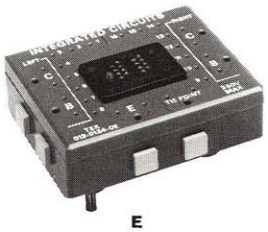
A

B




C

D




E

A

B

C

D

E

F

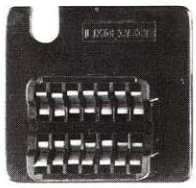
G

H

I

A

B



C

D

## DUAL WIDTH ADAPTORS

The following accessories fit the side-by-side terminals on test fixtures of the 576, 576/172, and 577/177 Curve Tracers.

**A. Transistor Adaptor** — Useful for most single and dual bipolar transistors and some MOS FETs. Order 013-0098-02 ..... **$230**

**B. FET Adaptor** — Useful for most single and dual FETs. Order 013-0099-02 ..... **$230**

**C. Long Lead Transistor Adaptor** — Accepts dual or single transistors with untrimmed leads. Order 013-0102-00 ..... **$205**

**D. Long Lead FET Adaptor** — Accepts dual or single FETs with untrimmed leads. Order 013-0103-00 ..... **$230**

**E. Integrated Circuit Adaptor** — Allows connection to multipin device packages. The appropriate multilead socket is plugged into the integrated circuits adaptor. The pins are then connected to the collector, base, or emitter terminals by means of the patch cord. A tie point is also provided so that an external power supply or signal source may conveniently be patched to the IC pins. Order the appropriate multilead socket listed separately. Order 013-0124-03. Includes 10 each 4 in test leads ..... **$415**

## KELVIN SENSING ADAPTORS

The following accessories fit the test fixtures of the 576, 576/172, 576/176, and 577/177 Curve Tracers.

**A. Transistor Adaptor** — Accepts long or short transistors. Can be rewired to accommodate nonstandard configurations. Order 013-0127-01 ..... **$85**

**B. In-Line Adaptor** — Accepts large and small transistors with in-line leads. The adaptor will accept devices with approx spacing between terminals of 0.06 in up to 0.18 in. It is wired for a B-C-E terminal configuration but may be easily rewired for the C-B-E configuration. Order 013-0138-01 ..... **$100**

**C. TO36 Adaptor** — Order 013-0112-00 ..... **$100**

**D. TO3 Adaptor** — Can be rewired to accommodate nonstandard configurations. Order 013-0100-01 ..... **$115**

**E. TO66 Adaptor** — Order 013-0101-00 ..... **$115**

**F. Axial Lead Diode Adaptor** — Order 013-0111-00 ..... **$105**

**G. Stud Diode Adaptor** — Order 013-0110-00 ..... **$100**

**H. Blank Adaptor** — For mounting special sockets. Order 013-0104-00 ..... **$60**

**I. Power Transistor Adaptor** — Order 013-0163-00 ..... **$120**

## MULTILEAD SOCKETS

These sockets are used with the Integrated Circuit Adaptor (013-0124-03) listed under Dual Width Adaptors, and with the 178 Test Fixture.

**A. 8 Lead TO Package** — Order 136-0444-00 ..... **$39**

**B. 10 Lead TO Package** — Order 136-0441-00 ..... **$46**

**C. 14 Lead Dual-in-line Package** — Order 136-0443-00 .. **$46**

**D. 16 Lead Dual-in-line Package** — Order 136-0442-00 .. **$44**

These four sockets are the most commonly required in curve tracer applications. Additional socket configurations, including zero insertion style, are available from Textool Products, Inc., 1410 W. Pioneer Dr., Irving, TX 75061.

# DIGITAL PHOTOMETER/ RADIOMETER

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Uncorrected Probe ..... 414
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### J16 Photometer/Radiometer

**Digital LED Readout**

**Freedom from Saturation Effects over Entire Range**

**Metric and US Versions Available**

**Accurate Spectral and Cosine Corrections**

**Ac or Internal Rechargeable Battery Versions**

**Longer Battery Life**

**Application Notes Available**

**Eight Silicon Sensor Probes Quickly Interchange without Recalibration**

**IMPROVED BATTERY LIFE**

The Tektronix J16 is a portable digital photometer/radiometer capable of making a wide variety of light measurements—in the laboratory, in the field, or on the production floor. A J16 System consists of a J16 mainframe and one of eight detachable probes. Probes can be either mounted on the J16 or used on the end of an extension cable. All probes have a HOLD switch to allow the reading to be held.

Eight quickly interchangeable probes are available for measuring illuminance, irradiance, luminance, light-emitting diode output, and relative intensity. Recalibration is not necessary when probes are interchanged. Connection of a probe to the J16 automatically selects the correct front panel units indicator. The 3½-digit LED display can be easily read under low ambient conditions.

All probes use silicon photo-diodes and multi-element glass filters for maximum stability and accuracy.

The improved J16 uses low power chips which enable it to run cooler, and increases the operating time of the battery powered version (standard and Option 01).

Under normal usage, the internal rechargeable nickel cadmium batteries will operate the J16 for four hours. An ac power supply is recommended for continuous operation.

Power supplies or battery packs can be changed quickly by removing four screws on the J16's rear panel. The cabinet and probes have an internal threaded socket (¼ inch x 20) for convenient mounting on a tripod or optical bench.

### J16-TV Package

The J16-TV package is an excellent transfer mechanism which provides a simple, accurate method for adjustment of monitor screen color temperature. The primary colors are measured and adjusted to produce white color temperature balance.

The J16-TV with optional J6503 or J6523 measures monitor screen brightness on both color and black and white monitors. Other applications include measurement of studio lighting, camera lighting, and illumination of work areas.

The J16-TV package includes: J16 Battery-operated Photometer, J6502 Irradiance Probe, light occluder, probe extension cable, and battery charger. See application note (58A-2926-1) for additional information.

**J6501**
**J6502**
**J6503**
**J6504**
**J6505**

**J6523**

**LED ADAPTOR (included with J6505)**
**014-0047-00**

**J6511 (shown)**
**J6512**

**42 IN PROBE EXTENDER CABLE**
**012-0414-02**

## J6511/J6501 Illuminance Probes

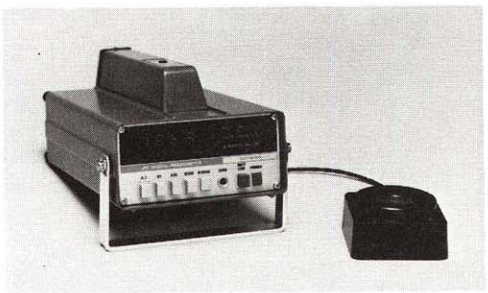
**Typical Applications: Measurement of roadway illumination, office lighting, illumination of work surfaces, studio lighting, and camera setup.**

The J6511 is an illuminance probe with readout in footcandles (lumens/m² (lux) for the J6511 Option 02). A multi-element glass filter and silicon photo-diode insure a close match to the CIE photopic curve (color corrected). The silicon-sensor recovery time is virtually instantaneous; low light levels can be measured immediately after exposure to bright sunlight.

The angular response is accurately cosine corrected, simulating an ideal 180° field-of-view detector. The low-profile probe has a leveling indicator to assure accurate measurements where a significant proportion of the illumination comes from sources at low angles to the horizon.

A 25-foot cable between the probe head and J16 allows the user to be out of the field of view while making measurements.

Where cosine correction is not necessary, a standard probe is available (J6501) with the same photopic correction and units as the J6511. The J6501 with the LED adaptor can be used to measure green and yellow LED's.



*The low-profile J6512 shown above is physically similar (without cosine correction) to the J6511.*

## J6502/J6512 Irradiance Probes

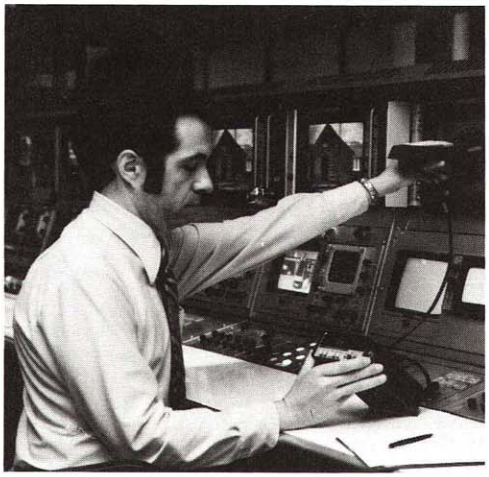
**Typical Applications: Laser research experiments, and measurements of radiant efficiency.**

The J6502/J6512 measure irradiance in microwatts/cm² (millwatts/m² with Option 02). The spectral response is flat from 450 nanometers to 950 nanometers, ±7%. The response is typically down 50% at 400 nm and 1030 nm.

An optional filter holder is available for the J6302 to mount standard 1-inch diameter customer-supplied filters of up to ⅜ inch thickness. Where high intensity sources are used (over 1990 μwatts/cm²), neutral density filters can be used to extend the range of the J16. (An ND 1 filter has 10% transmission, an ND 2 filter has 1%, etc.). These filters may be held with optional filter holders.

Where the 1 sq cm sensor is not completely filled by the source for example with a laser beam, the reading obtained represents μwatt instead of μwatts/cm² or milliwatts x $10^{-4}$ instead of milliwatts/m² (Option 02). Small variations in sensor uniformity may add ±5% uncertainty to this measurement.

The J6512 has a low-profile detector head that is at the end of a six foot cable. Longer cables can be ordered as a special modification.



*J16-TV System being used for color monitor setup.*

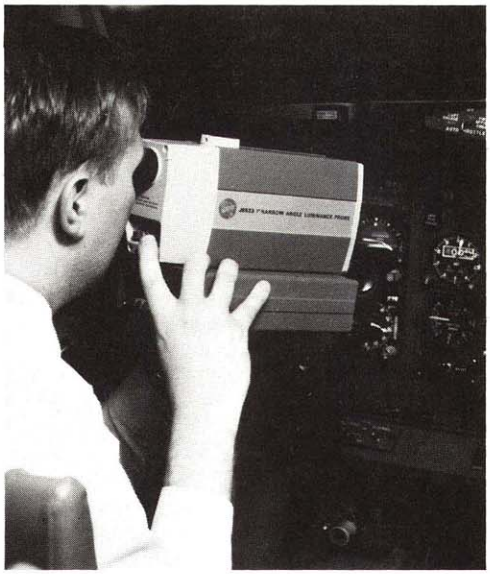
## J6503 8° Luminance Probe

**Typical Applications: Measuring brightness of video screens, street signs, light reflected from work surfaces, and movie screens**

The J6503 measures luminance in footlamberts (candelas/m² (nit) with Option 02) where light scattered or emitted by a surface must be measured. The probe is pointed at the emitting surface.

The probe's response is closely matched to the CIE photopic curve, assuring accurate results even when measuring spectrally different light sources.

The acceptance angle is approximately 8°, which is determined by internal field stop apertures. Providing that the 8° field is uniformly filled, the probe can be held at any distance from the source. At 21 inches from the front of the probe, the field of view is approximately three inches in diameter. The footlambert or candelas/m² (nit) (Option 02) indicator automatically lights when the J6503 is connected.



*Measuring Luminance with the Tektronix J16/J6523.*

## J6523 1° Luminance Probe

**Typical Applications: Measuring highway lighting, video displays, photographic equipment, and lighting equipment.**

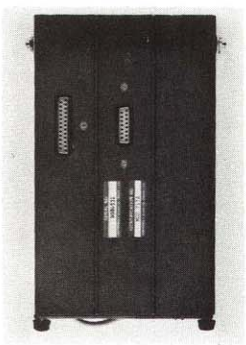
The J6523 will measure the luminance in footlamberts (candelas/m² with Option 02) of a spot as small as 0.32 inch in diameter. By using commercially available 55 mm stackable diopters, areas as small as 0.035 inch (+10 diopters) can be measured. These 55 mm diopters are physically similar to threaded 55 mm filters, and are available from most photography stores. (See application note 58AX-3252).

The 1° angle represents 0.21 inch per foot of distance from the probe to the source. Thus at 10 feet, the J6523 measures a 2.1-inch diameter spot.

The probe includes an optical sighting system with a 9° viewing field. The focusing range is 18 inches to infinity, closer with 55 mm close-up diopters. The spectral response is closely matched to the CIE photopic curve (color-corrected) for accurately measuring all commonly used light sources.

The J6523 may be attached to the J16 or used with an optional probe extension cable. A standard ¼ in x 20 threaded socket allows it to be used on a tripod or an optical bench.

**MODIFIED J16 WITH ANALOG/BCD OUTPUT**



**ANALOG/ BCD OUTPUT CONNECTOR** →

**AC POWER SUPPLY**

**BATTERY PACK**

**BATTERY CHARGER**

## J6504 Uncorrected Probe

**Typical Applications: Checking light sources used in photo-resist or photoprocessing applications, and comparisons of ultraviolet light sources.**

This probe is designed for applications where only relative measurements need be made. The J6504 has the widest spectral range, and is the most sensitive probe. Use is made of a UV-enhanced silicon sensor and a UV-transmitting window rather than spectral-correction filters.

No units are indicated on the three front panel indicators when using the J6504, since it provides relative readings only.

An optional filter holder may be used to mount standard 1-inch diameter filters on standard-configuration probes. Ultraviolet, visible, or near infrared filters can be used to select the wavelength of interest and exclude ambient light.

## J6505 Red LED Test Probe

**Typical Applications: Measurement of light-emitting diodes (LED) having spectral outputs in the red region (600 nm to 710 nm).**
*Note: For yellow or green LED's use the J6501 Probe.*

The J6505 measures illuminance in footcandles (lumens/m² (lux) with Option 02), which can easily be converted into luminous intensity in candelas. (See application notes 58A-2635 and 58A-2704-1.)

An adaptor supplied with the probe provides a controlled spacing between the sensor and the LED under test. The adaptor excludes ambient light, and has internal baffles to prevent stray reflections during the measurement. Three inserts are supplied with the adaptor to fit common sizes of LED's (0.080 inch, 0.125 inch, and 0.200 inch in diameter). These inserts are made of soft plastic that can be easily modified by the user.

With the adaptor in place, a reading of 1 footcandle on the J16 represents 100 millicandelas of luminous intensity. With a metric version of the J16/J6505 (Option 02), 1 lumen/m² represents 10 millicandelas. A 10X increase in sensitivity is available on special order.

In the J6505, the silicon photodiode-filter combination provides an excellent match to the photopic curve in the region 600 nm to 710 nm. This close match requires compromising in the 380 nm to 600 nm region making this probe unsuitable for general illuminance measurements. For LED measurements in the yellow or green region, the LED adaptor must be used with the J6501 and the same conversion factor for luminous intensity applies.

**PROBE CHARACTERISTICS**

| Application | | Illuminance | | Irradiance | Luminance | | Uncorrected | Red LED |
|---|---|---|---|---|---|---|---|---|
| Probe | | J6501 | J6511 | J6502/J6512 | J6503 | J6523 | J6504 | J6505 |
| Range | US*2 | 0.001 to 1999 footcandles*1 | 0.001 to 1999 footcandles | 0.001 to 1999 microwatts/cm² | 0.1 to 199,900 footlamberts*1 | 0.1 to 19,990 footlamberts*1 | Relative response only | 0.001 to 1999 footcandles*1† |
| | Metric (Opt. 02)*2 | 0.01 to 19,990 lumens/m² (lux)*1† | 0.01 to 19,990 lumens/m² (lux) | 0.01 to 19.990 milliwatts/m² | 1 to 1,999,000 candelas/m² (Nits)*1 | 1 to 199,900 candelas/m² (Nits)*1 | Relative response only | 0.01 to 19,990 lumens/m² (lux)*1† |
| Accuracy (Including J16) | | Within 5% of NBS standards and ±1 digit in last place. Calibrated with a 3100° k tungsten halogen light source traceable to NBS | | Same as J6501, except calibrated with a 762 nm filter | Within 5% of NBS standards and ±1 digit in last place. Calibrated with a 3100° k tungsten halogen light source traceable to NBS | | Probe-to-probe accuracy ±5% with tungsten light source | Same as J6501, except calibrated with a 656 nm filter |
| Spectral Response | | Within 2% (integrated) of CIE photopic curve | | Flat within ±7% from 450 to 950 nm | Within 2% (integrated) of CIE photopic curve | | UV enhanced silicon spectral curve (250 to 1200 nm) | Within 2% (integrated) of CIE photopic curve from 600 to 710 nm |
| Acceptance Angle | | 50% sensitivity at 48° off axis | Cosine corrected (180°) | 50% sensitivity at 48° off axis | 8° | 1° | 50% sensitivity at 48° off axis | |
| Stability and Repeatability | | Within 2% per year | | | | | | |
| Linearity | | Within 2% over entire range enabling single point calibration | | | | | | |

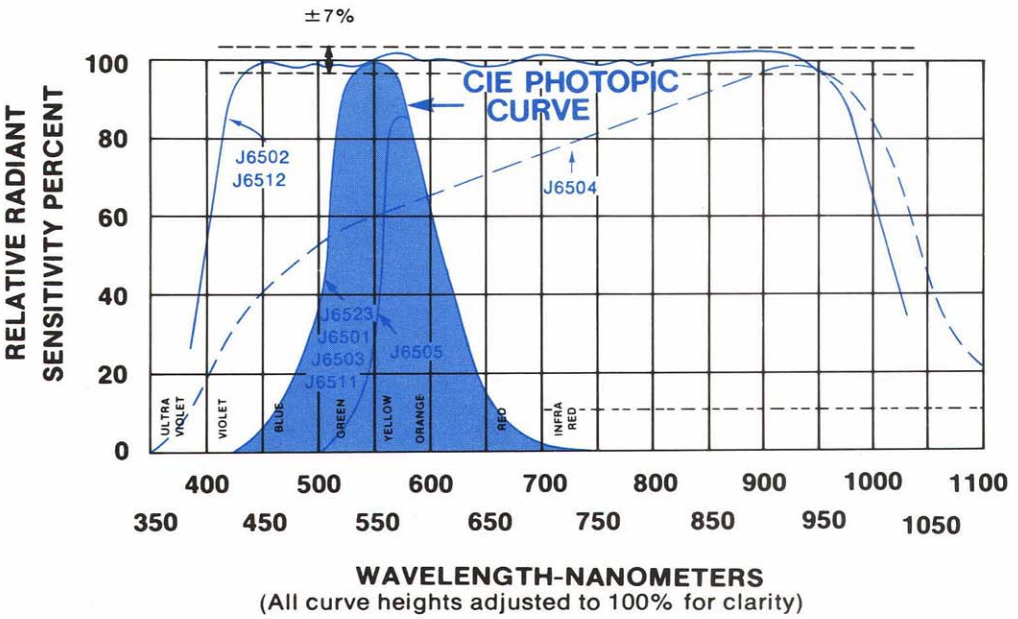
**1 An additional decade of sensitivity is included and is usable if the J16 is carefully zeroed and used at a relatively stable temperature.*

*† 0.00001 to 199.9 candelas when used with 014-0047-00 LED adaptor or at 3.8 inches source-to-sensor spacing. Luminous intensity readings of higher intensity light sources may be easily made at correspondingly greater distances using the formula: Footcandles x d²=candelas where d is the distance from the source to the sensor in feet. (For metric readings use lux x d²=candelas where d is distance from the source to the sensor in meters.) Request J16 Application Notes 58A-2635 and 58A-2704-1 for further information.*

**2 U.S./METRIC CONVERSIONS*

| | U.S. to Metric | Metric to U.S. |
|---|---|---|
| Illuminance | Fc x 10.764 = Lux | Lux x 0.0929 = Fc |
| Luminance | Fl x 3.426 = Nits | Nits x 0.2919 = Fl |

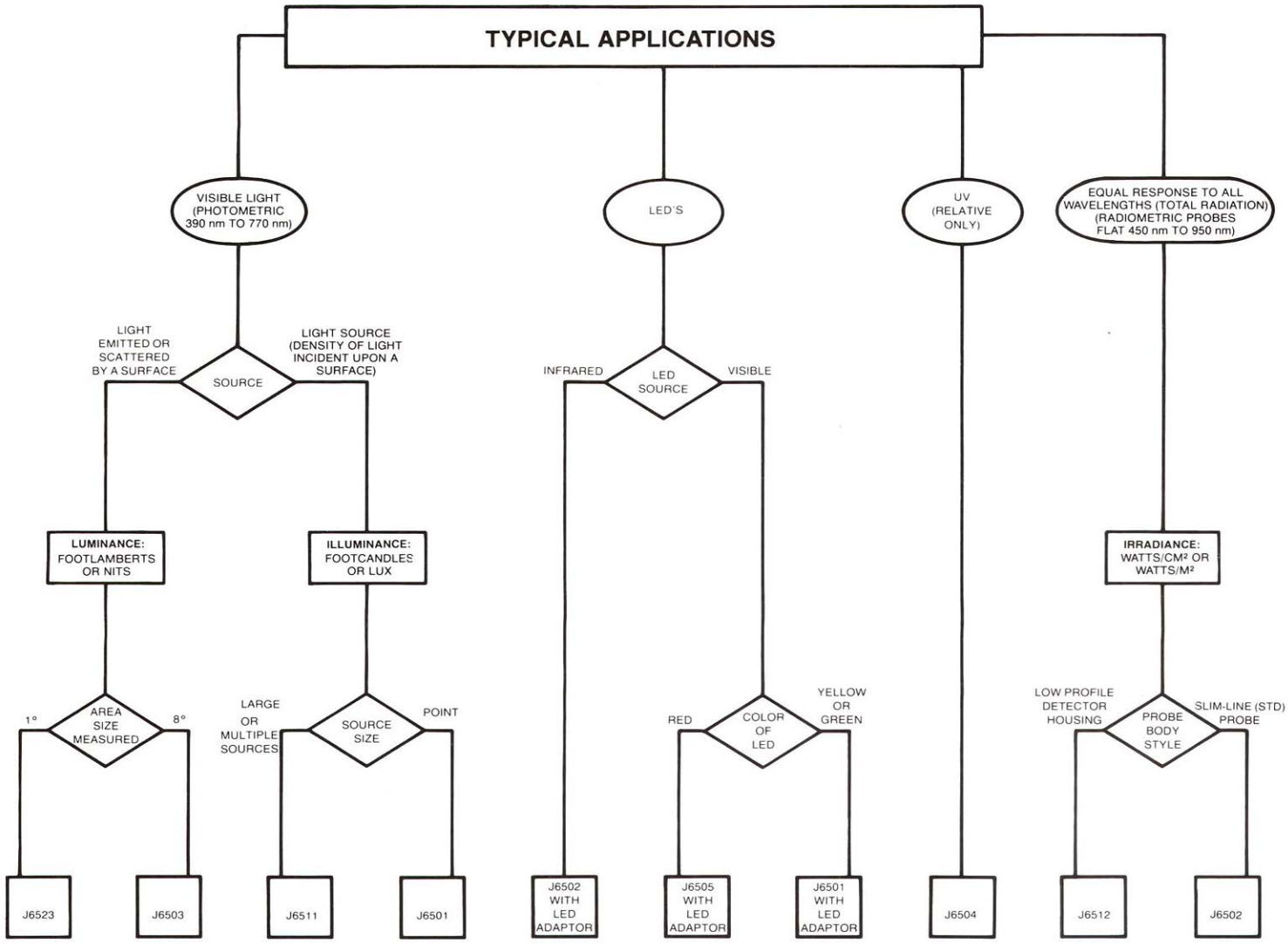
### TYPICAL PROBE SPECTRAL CHARACTERISTICS




*NOTE: C.I.E. stands for the International Commission on Illumination.*

## J-16 PROBE SELECTION GUIDE

The following flowchart is an aid in selecting J-16 probes. The applications for the probes are too numerous to list, but this should help in your selection.




### GLOSSARY

**Photometry** — The measurement of light visible to the human eye.

**Radiometry** — The measurement of light within the total optical spectrum.

**Color Temperature** — The temperature of a blackbody whose radiation has the same visible color as that of a given nonblackbody radiator. Usually expressed in °k.

**Foot-candle** — Unit of incident illumination.

**Foot-lambert** — A unit of illumination emitted or diffusely reflected by a source.
Two additional units are commonly used—the lux (the metric unit of illuminance) and the nit (the metric unit of luminance).
1 foot-candle = 10.76 lux
1 foot-lambert = 3.426 nits

**Illuminance** — The amount of luminous flux through a unit of surface area and is usually measured in foot-candles (lumens/ft²).

**Inverse Square Law** — The decrease of light intensity with increasing distance. Twice the distance, reduces the illumination to one-quarter.

**Irradiance** — The amount of radiant flux received by a unit of surface area and is usually measured in watts/cm²*¹.

*¹ Other units of irradiance such as μW/cm² and W/m² are also used extensively.*

**Lambert's Law** — Describes the spatial characteristics of a perfectly diffusing surface which may be either emitting or reflecting light. The light emitted or accepted by such a surface decreases with angle (from perpendicular) according to the cosine of the angle.

**Luminance** — The amount of light emitted or scattered by a surface and is usually measured in foot-lamberts.

**Photopic** — Spectral (color) sensitivity of the average human eye, predominantly peaked in the yellow-green region.

**Steradian** — A unit of area on the surface of a sphere equal to the radius squared. There are 12.6 steradians total area on a sphere.

**Spatial** — The directional characteristics of light in space.

**Spectral** — The distribution of light by wavelength within an electromagnetic spectrum.

*Note that each radiometric unit has a photometric equivalent differing only in spectral response of the sensor. However, the units are not interchangeable.*

## CHARACTERISTICS (J16)

**Display** — 3½-digit LED readout and three LEDs automatically indicating correct units for probe in use. Metric version read ut is also available (Option 02).

**Stability** — Within 2% per year.

**Linearity** — Within 2% over the entire range, enabling single point calibration.

**Integration Time** — ≈100 ms.

**Calibration** — Electrical calibration of the J16 mainframe is performed by use of a calibrated voltage source or DVM traceable to NBS. Calibrated probes can be used with any J16 without additional calibration.

### POWER REQUIREMENTS

Standard and Option 01: Has internal rechargeable NiCd batteries that require 16 hours for a full charge. The J16 will nominally operate four hours continuously on a charge. The J16 cannot be operated from the battery charger for continuous operation since the charging rate is ≈200 mA, while the J16 draws ≈400 mA. For continuous operation an ac power supply is recommended.

Option 03 and Option 04: Ac only operation, no internal batteries.

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Nonoperating: −50°C to +75°C. Operating: −15°C to +40°C.

**Altitude** — Nonoperating: To 15 000 m (50,000 ft). Operating: To 4600 m (15,000 ft).

**Humidity** — Operating and Storage: Five cycles (120 hour) to 95% relative humidity at 40°C. Referenced to MIL-E-16400F.

**Vibration** — Operating: 15 minutes along each of the three major axes at a total displacement of 0.025 in p-p (4 g's) from 10 Hz to 55 Hz to 10 Hz in one minute cycles. Hold for three-minutes at 55 Hz. All major resonances must be above 55 Hz.

### PHYSICAL CHARACTERISTICS WITH PROBE AND BATTERY PACK INSTALLED

| Dimensions | mm | in |
|---|---|---|
| Width | 123 | 4.6 |
| Height | 60 | 2.4 |
| Depth | 203 | 8.0 |
| **Weights ≈** | **kg** | **lb** |
| Net | 1.5 | 3.3 |
| Domestic Shipping | 2.3 | 5.0 |
| Export-packed | 4.5 | 10.0 |

### INCLUDED ACCESSORIES

**Battery Versions** — Standard J16 and Option 01: Battery charger (119-0375-02 or 119-0375-03); shoulder strap (346-0104-00); battery pack (016-0539-01); instruction manual.

**Ac Only Versions** — J16 Option 03 and Option 04: Ac power pack (119-0404-00 or 119-0404-01); shoulder strap (346-0104-00); instruction manual.

**J16-TV Versions** — Depending on the option, the same accessories listed above plus the items listed in the J16-TV package.

## ORDERING INFORMATION

**J16** Photometer/Radiometer (Includes 115 V ac, 50 Hz to 400 Hz Battery Charger, Does Not Include Probes) ..... **$1,245**

**Option 01** — As above, but includes 230 V ac, 50 Hz to 400 Hz battery charger ..... **NC**

**Option 02*¹** — Metric readout for J16 (requires Option 02 probes) ..... **NC**

**Option 03** — 115 V ac only operation, 50 Hz to 400 Hz .. **NC**

**Option 04** — 230 V ac only operation, 50 Hz to 400 Hz .. **NC**

**BCD and Analog Outputs** — A custom modified J16 is equipped with an added 25-pin connector on the cabinet top, providing digital logic and BCD readout outputs, a "hold" input and an analog signal output, for remote data reduction. A mating cable-end connector and connector cover have been added to the accessories complement. Contact your Tektronix representative for price and delivery information.

**¹ Option 02 must also be selected for probes.*

### TELEVISION MEASUREMENTS

**J16-TV** Photometer/Radiometer Package For TV Color Monitor Setup. The Package Includes J16 Battery-Operated Photometer, J6502 Irradiance Probe, Light Occluder, 42 In Probe Extension Cable ..... **$1,865**

Available with Options 01, 02, 03 and 04 above.

### PROBES

**J6501** Illuminance Probe ..... **$585**

**J6502** Irradiance Probe ..... **$585**

**J6503** 8° Luminance Probe ..... **$585**

**J6504** Uncorrected Probe ..... **$550**

**J6505** LED Probe, Includes LED Adaptor ..... **$585**

**J6511** Illuminance Probe, Cosine Corrected (with 25 ft cable) ..... **$565**

**J6512** Irradiance Probe (with 6 ft cable) . **$570**

**J6523** 1° Luminance Probe ..... **$1,660**

**Option 02** — Metric probes required for metric readout J16's (Option 02) ..... **NC**

**Option 05** — Actual spectral curve of any probe (available on initial order) ..... **+$40**

### OPTIONAL ACCESSORIES

**42 in Probe Extender Cable** — Connects J16 and probe. Order 012-0414-02 ..... **$105**

**Probe Extender Cables** — Up to 30 ft in length. Available on special order through your local Tektronix Sales Office.

**Light Occluder** — For TV color monitor balancing. Order 016-0305-00 ..... **$25**

**Filter Holder** — Mounts 1 in diameter filters, of up to ⅜ in thickness, to probes (except J6511, J6512, J6523). Order 016-0527-00 ..... **$30**

**LED Adaptor** — Included with J6505. Order 014-0047-00 . **$85**

Power packs can be quickly changed by removing four corner screws on the J16's rear panel and sliding the power supply or battery pack out.

**Ac Power Supply** — Allows J16 to be used without batteries.
Order 119-0404-00 115 V ac, 50 Hz to 400 Hz ..... **$230**
Order 119-0404-01 230 V ac, 50 Hz to 400 Hz ..... **$240**

**Spare Battery Pack** — Order 016-0539-01 ..... **$155**

When ordering a battery pack for your ac-powered J16, also order one of the following chargers.

**Battery Charger** — 115 V ac, 50 Hz to 400 Hz. (Included with Standard J16.) Order 119-0375-02 ..... **$60**

**Battery Charger** — 230 V ac, 50 Hz to 400 Hz. (Included with Option 01.) Order 119-0375-03 ..... **$50**

Within the basic limitations of the silicon sensors and the J16 design, a number of modifications are possible. Contact your local Tektronix Sales Office or Representative regarding special application requirements.

## J16 APPLICATION NOTES

These can be obtained from your local Tektronix representative.

| DESCRIPTION | REQUEST NO |
|---|---|
| Luminous intensity and visible LED measurements with the Tektronix J16 Photometer. | 58A-2635 |
| Measuring pulsed light sources with the J16 and an oscilloscope. | 58A-2702-1 |
| Radiant intensity and infrared emitting diode measurements. | 58A-2704-1 |
| Radiometry and photometry for the electronics engineer. | 58A-2578 |
| Television station applications for the J16 Photometer. | 58AX-2764-1 |
| Practical lighting measurements with the Tektronix J16. | 58A-2912 |
| TV picture monitor color temperature adjustment using the Tektronix J16. | 58A-2926-1 |
| Photographic exposure measurements with the Tektronix J16. | 58AX-3060-1 |
| Measuring the luminance of small areas of light with the J16 and J6523. | 58AX-3252 |
| Optical communications measurements. | 58AX-3602 |

# ACCESSORIES

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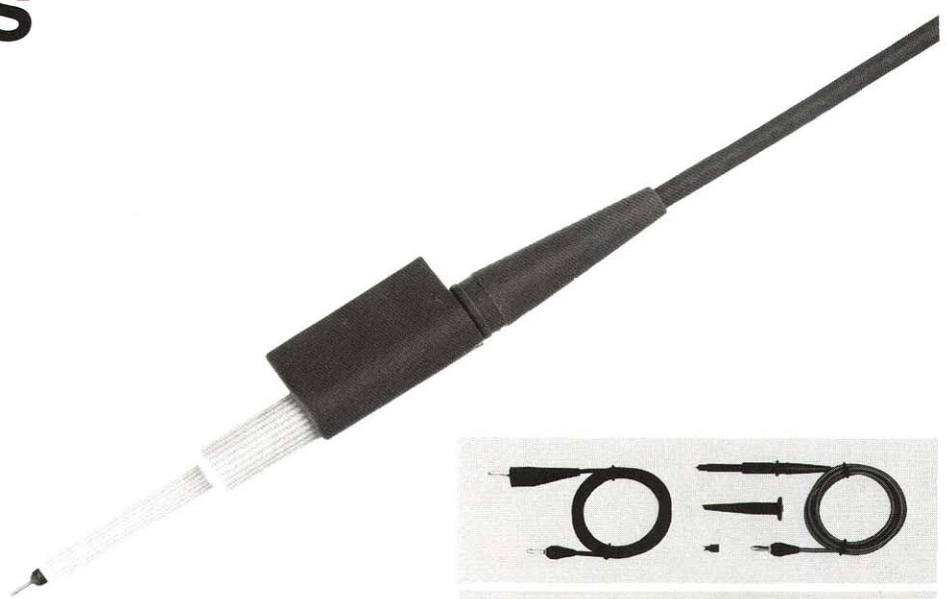
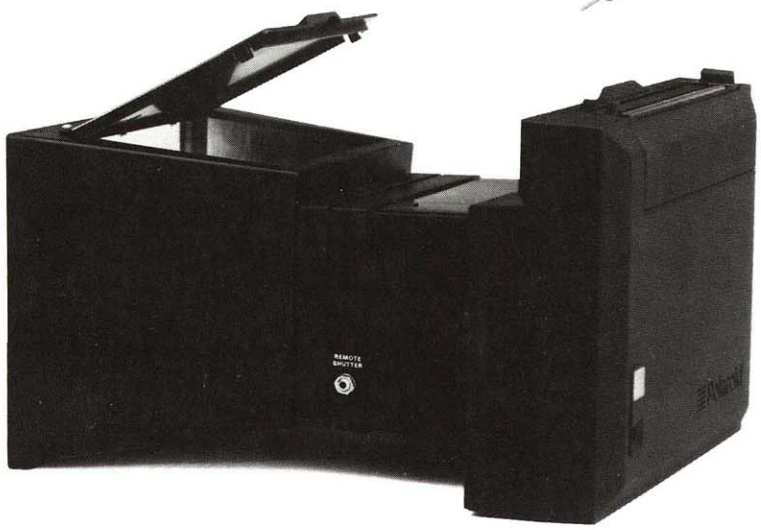
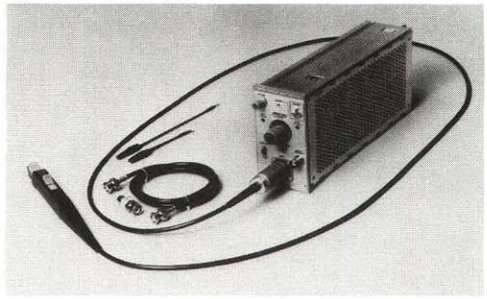
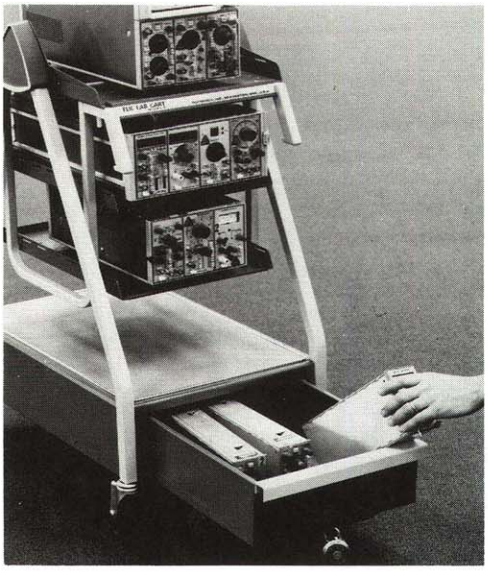








**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

# Choosing a Tektronix Camera . . .

## An Overview of Tektronix Camera Families

A camera can be a key part of your measurement system. It allows you to capture single events and document your results, and it helps you communicate your results with clarity and credibility. The following pages give information to help you select a camera well suited to your needs.

### MOUNTING ADAPTORS

The table on page 420 indicates the camera adaptors required for most Tektronix instruments and a few by other manufacturers. In some cases, adaptors are available from Hewlett-Packard or others to mount Tektronix cameras to their instruments.

### POWER REQUIREMENTS

**C-50 Series**

The C-51 and C-53 electric shutters require +15 volts, normally supplied by a 7000 Series oscilloscope. An optional battery pack (016-0270-02) is available for situations where one of these cameras is used on a non-7000 Series instrument. These shutters can be actuated by a switch closure to ground. The C-59A has internal batteries or uses power from the 7000 Series mainframe.

**C-5C**

The C-5C uses four AA alkaline batteries.

**C-7**

There are three choices of power with the C-7: battery pack that holds eight AA alkaline batteries; ac power supply; or remote power.

### GRATICULE LIGHTING

Most scopes have graticule illumination. For those that do not, an image of the graticule may be obtained by using the flash on the C-5C or C-7 Cameras, or a storage scope's background (flood guns).

### LENSES

Tektronix camera lenses differ mainly in light gathering ability, magnification, and field of view.

**Speed**

The f-number of a lens inversely signifies its aperture area and light gathering ability. For example: the aperture area of an f/1.4 lens is four times that of an f/2.8 lens of the same magnification and gathers four times the light. The relative light gathering ability of all lenses used in Tektronix cameras is referenced to the f/1.9, 0.85 magnification lens which is arbitrarily rated at 1.0. For recording a stored or stable recurrent CRT display, a lens as slow as the f/16 type used in the C-5C and the C-7 Cameras is adequate. However, to record a fast, dim, single-sweep trace, you may need a lens as fast as the f/1.2 types used in the C-31B and C-51 Cameras.

**MAXIMUM MAGNIFICATION TO RECORD ENTIRE SCREEN**

| Screen Size | 5 cm x 6.3 cm | 7.2 cm x 9 cm | 8 cm x 10 cm | 9.76 cm x 12.2 cm |
|---|---|---|---|---|
| Polaroid 3¼ in x 4¼ in pack and roll film | 1.0 | 1.0 | 0.85 | 0.67 |
| 4 in x 5 in films | 1.0 | 1.0 | 1.0 | 0.85 or less |
| 6 cm x 7 cm format roll film (70 mm, 120 mm, 220 mm, etc.) | 1.0 | 0.67 | 0.67 | not recommended |

**Field of View**

The description for each camera includes a statement of its field of view; this signifies how large a CRT display the camera can fully record. It is determined by the combined effects of the magnification and angular field of view of the lens, any field-limiting apertures in the camera adaptor, camera body, film holder, and the image area of the film. (See "Maximum Magnification" chart on this page.)

**Magnification**

Modern optical technology has made possible wide-aperture, wide-angle, flat-field lenses with short focal length for more compact cameras. To realize their inherent low distortion, high resolution, and uniform focus, these fixed focal length lenses must be used at their design center magnification.

Operating such lenses at a different magnification tends to compromise their important performance characteristics. For this reason, most Tektronix cameras are designed for use at one lens magnification. One exception is the C-30B Camera which has a magnification range of 0.7 to 1.5 (at some increase in distortion at the magnification extremes) to accommodate several portable oscilloscopes that have displays ranging in size from 3.8 cm x 6.3 cm to 8 cm x 10 cm.

The rated magnification of a lens signifies its image-to-object ratio. Note in the table above that only an image-to-object ratio of less than 7:1 can record the trace of a 6½ inch CRT.

For maximum resolution, the lens should produce the largest complete image possible within the image area of the film. The film most widely used for oscilloscope trace recording is Polaroid Type 667 pack film which has an image area of 73 mm x 95 mm. In most cases, the magnification is selected to provide the largest possible complete image of a particular display. An exception is in high writing speed applications where a 0.5 magnification lens is usually used to achieve higher writing speed by concentrating the trace light in a smaller area of the film.

### SHUTTERS

Of the two available types of shutters, mechanical shutters are simple to operate and are economical. They are actuated by pressure on a release mechanism. Electrical shutters permit remote, automatic, or manual release and offer higher reliability. They may be actuated by an insulated switch closure.

### VIEWING

The C-30 Series and the C-50 Series are hinge mounted and can be swung aside to allow a wide-angle view of the CRT. The light-weight C-5C and C-7 can easily be removed to view the CRT or you can use the viewing door in the flash unit. C-5C's and C-7's without a flash have a large lift-up viewing door in it's place. The C-50 Series cameras have an off-axis viewing hood that accommodates eyeglasses for a comfortable binocular view of the CRT display while excluding ambient light.

### FILM BACKS

Depending on your application you can choose from a wide variety of cameras and backs. Backs within a series are interchangeable. (See the specific camera for information on a particular back.)

**STANDARD AND OPTIONAL FILM BACKS AND HOLDERS AVAILABLE FROM TEK**

| | C-30 Series | C-50 Series | C-4, C-5C, C-7 |
|---|---|---|---|
| **Tek Modified Polaroid Backs** | | | |
| 3¼ in x 4¼ in pack | Std on "P" models | Std on "P" models | Noninterchangeable (C-5C & C-4) |
| Roll*1 | Yes*1 | Yes*1 | NA |
| 4 in x 3 in Auto Film | NA | NA | C-7 Only |
| **Graflok-Type*2 Interface** | Optional*2 Back | Std on*2 "G" Models | NA |
| Polaroid 3¼ in x 4¼ in pack holder | Yes | Yes | |
| Polaroid 4 in x 5 in single sheet holder | Yes | Yes | |
| Polaroid 4 in x 5 in pack holder*3 | *3 | *3 | |
| 120 mm roll | Yes | Yes | |
| 70 mm roll | Yes | Yes | |
| 4 in x 5 in cut film holder*4 | *4 | *4 | |

**1 Polaroid is gradually reducing the number of its roll films. Scope camera roll backs are available in limited quantities from Tektronix.*

**2 Requires one of the film holders listed in order to be useable.*

**3 Will work but available only from Polaroid.*

**4 Will work but not available from Tek, see your local camera store.*

### FILMS

Polaroid films are the most convenient to use. They offer the advantages of development in seconds to a finished dry print with wide spectral response, good resolution, and high sensitivity. ASA ratings do not necessarily give a true indication of how a film will respond in CRT recording due to the narrow spectral output range of most phosphors and different spectral sensitivity of various film types. See table on page 419 for listing of Polaroid films. Wet process, roll, or cut films can be used if the proper back is selected. (See the respective camera for optional backs.)

Manufacture of Polaroid 410 ROLL film, ASA 10,000, has been discontinued. Polaroid 612 PACK film, ASA 20,000, is now available for most high speed applications.

### BLACK BODY COLOR STANDARD

All Tektronix cameras are supplied with a standard black body finish.

**Technical assistance with Polaroid film and back questions or problems is available directly from The Polaroid Corporation. Call 1-800-225-1618 toll free within U.S.**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## PHOTOGRAPHIC WRITING SPEED

Photographic writing speed signifies the ability of a particular oscilloscope/camera system to provide a useful photographic record of a fast single-sweep trace. It is stated as an oscilloscope performance characteristic and is expressed in cm/$\mu$s or cm/ns. It is designed to answer the question, "What is the speed of the fastest single-sweep trace the system can record?" All statements of writing speed must specify the measurement conditions, including the CRT phosphor and film used, and the definition of a readable trace image.

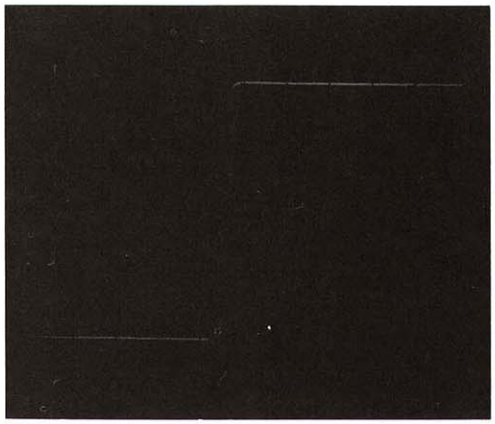
### Increasing Writing Speed

Film fogging is a technique for increasing the maximum sensitivity of photographic film by giving it a short exposure to dim, diffuse light. The Tektronix Writing Speed Enhancer (WSEN) is designed to fill this need.

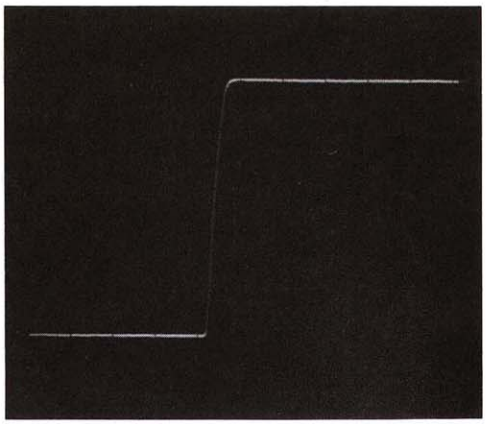
The enhancer installs in minutes, and can be triggered in three ways; by a pushbutton on the control box; remotely, with a switch closure to ground (such as provided by the camera-shutter x-sync switch); or by the oscilloscope-sweep + gate.

Thus, the film can be fogged before, after, or while the sweep occurs. The techniques are respectively called prefogging, postfogging, and simultaneous fogging. Of these modes, simultaneous fogging provides the greatest gain in writing speed. Automatic, simultaneous fogging is easily achieved by triggering the enhancer with the oscilloscope-sweep + gate.

**For more information on photographing high speed signals request application note 42W-5335-1.**



*Polaroid Type 107, 3000 speed pack film was exposed to the single-trace display of a pulse waveform with a fast rising leading edge too dim to produce a developable image.*



*Film from the same pack was exposed to the same single-trace waveform and simultaneously to light from a Writing Speed Enhancer. The enhancer light supplied the additional photons needed at the weak film development centers formed by the dim leading edge, to produce a visible image of the entire waveform.*

*WSEN (Writing Speed Enhancer) diffuser with control box.*

| POLAROID FILM | | RELATIVE FILM WRITING SPEED | |
|---|---|---|---|
| ASA Equivalent Speed | Type | Unfogged | Using a WSEN Fogged |
| 3,000 | 667, 107, 084, 47 | 1 (Reference) | 3*2 |
| 20,000 | 612*1 | >2 | >3.5*2 |

*1 Polaroid 612 PACK film, ASA 20,000, is now available with faster writing rate than previous 410 ROLL film.
*2 Value depends on film, scope, CRT, camera and the operator.

**The more commonly used films for each type of camera back are listed below. Shaded text indicates preferred films.**

### POLAROID FILMS

| Film Type | ASA Equivalent Speed | Development Time (Seconds at 75°F) | Format | Resolution (Line Pairs/mm) | Characteristics | CRT Recording Uses: Repetitive | Stored | Video Display (Gray Scale) | Scintillation Type Medical | Color Displays | Single Sweep | Scanning Electron Microscope |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **3 1/4 in x 4 1/4 in PACK FILMS — Actual image area 7.3 cm x 9.5 cm (2 7/8 in x 3 3/4 in), 8 Prints Per Pack** | | | | | | | | | | | | |
| 611*1 | 200 | 45 | Positive Print | 20 | Low Contrast, Wide Gray Scale | | | x | x | | | • |
| 612 | 20,000 | 30 | Positive Print | 20 to 25 | High Contrast | | | | | | x | |
| 665 | 75 | 30 | Negative | 160 to 180 | Medium Contrast, Wide Gray Scale | • | • | • | | | | x |
| | | | Positive Print | 14 to 20 | | | | | | | | |
| 107 | 3000 | 15 | Positive Print | 16 to 20 | Medium Contrast | • | • | • | | | • | |
| 084 | 3000 | 15 | Positive Print | 16 to 22 | Medium Contrast | • | x | • | x | | | |
| 667*1 | 3000 | 30 | Positive Print | 11 to 14 | Medium Contrast | x | x | • | x | | • | x |
| 669 | 80 | 60 | Color Positive Print | 11 to 14 | Balanced for Color—Electronic Flash | • | | • | | x | | |
| **AUTO FILM (For C-7 ONLY)*4 — Actual Image Area 10 cm x 7.5 cm (4 in x 3 in), 10 Prints Per Pack** | | | | | | | | | | | | |
| T-331*1*3 | 200 | 60 | Positive Print | 20 | Medium Contrast, Extended Gray Scale | • | • | x | x | | | • |
| T-336*1 | 100 | 60 | Negative Transparency | 40 to 100 | Medium Contrast, High Resolution | | | x | | | | • |
| T-339*1*2 | 640 | >60 | Color Positive Print*2 | 7 to 9 | Medium Contrast, High Speed Color | | | •*2 | | x*2 | | |
| **SHEET FILMS — Actual Image Area 3.9 cm x 11.4 cm (3 1/2 in x 4 1/2 in)** | | | | | | | | | | | | |
| 55 | | | Positive Print | 22 to 25 | | | | | | | | |
| 55 P/N | 50 | 20 | Negative | 150 to 160 | Medium Contrast, Wide Gray Scale | • | • | • | | | | |
| 57 | 3000 | 15 | Positive Print | 16 to 20 | Medium Contrast | x | x | • | | | • | |
| 552 (8 Pack) | 400 | 20 | Positive Print | 20 to 25 | Medium Contrast | • | • | x | | | | x |

**Polaroid Roll Film Backs are no longer available from Tektronix on new cameras. Polaroid still manufacturers some roll films...Call their toll free number 1-800-225-1618 for film availability.**

*x Preferred film for application.*
*• Acceptable performance.*
**1 No coating required.*
**2 Requires electronic scan reversal to yield a correct reading image.*
**3 Similar to Type 611.*
**4 Available from Polaroid or their profession dealers.*

## SELECTION GUIDE FOR CAMERAS AND MOUNTING ADAPTORS

**Where two or more cameras are recommended, compare features and specs to optimize for your application.**

| OSCILLOSCOPE OR DISPLAY DEVICE | RECOMMENDED CAMERAS | | | MOUNTING ADAPTOR PART NUMBERS | | | |
|---|---|---|---|---|---|---|---|
| | HIGH WRITING RATE | GENERAL PURPOSE | LOW COST | C-4*11 | C-5C, C-7 | C-51, C-53, C-59A, C-27, C-28 | C-30B, C-31B |
| **5000 Series** | | | | | | | |
| 5100 Series Nonstorage*1*2*3 i.e.; 5110, 5112, D10, D12, 577/D1, 5116 | | C-59A | C-4 Opt 02*11 C-5C; C-7, C-7 Opt 01 | 122-0895-01*11 | 016-0357-01 | 016-0249-06 | Not recommended |
| 5100 Series Storage*1*2*4 i.e.; 5111, 5111A, 5113, 5115 D11, D13, D15, 577/D2 | | C-59A | C-4 Opt 02*11 C-5C C-7, C-7 Opt 01 | 122-0895-01*11 | 016-0357-01 | 016-0249-06 | Not recommended |
| 5400 Series Nonstorage*1*2 i.e.; 5403/D40, 5440, 5444, D40 | | C-59A | C-4 Opt 02; C-5C; C-7, C-7 Opt 01 | 122-0895-01*11 | 016-0357-01 | 016-0249-06 | Not recommended |
| 5400 Series Storage*2*4 i.e.; 5403/D41, 5441, D41 | C-51 | C-53 | C-4 Opt 02 C-5C; C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | 016-0249-06 | 016-0248-01 |
| 5223*1 | | C-59A | C-4 Opt 02 C-5C; C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | 016-0249-06 | Not recommended |
| **7000 Series** | | | | | | | |
| 8 cm x 10 cm Display i.e.;7104, 7503, R7103, 7504, 7514, 7613N, 7623, 7633, 7704(A), 7834, 7844, 7854, R7903, 7904, 7904A, T922R*2 | C-51 C-31B Opt 01*10 | C-53 C-30B Opt 01*10 | C-4 Opt 02 C-5C C-5C Opt 01 C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | 016-0249-06 | 016-0248-01 |
| Large Screen Display i.e.;*1 7403, 7603, 7603N | | C-59A | C-4 Opt 02 C-5C; C-5C Opt 01 C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | 016-0249-06 | Not recommended |
| **Portables***5 | | | | | | | |
| Older with 0.8 cm Graticule i.e.; 422, 453, 454, 485, 491 | C-31B | C-30B | | | No adaptor | No adaptor*5 | 016-0306-01 |
| Newer w/1 cm Graticule i.e.;*7 2235 Option 01; 2445, 2465, 455, 464, 465, 465B, 465M,466, 468, R468, 475, 475A, 432, 434, 442 | C-31B Opt 01 | C-30B Opt 01 | C-4; C-7 Opt 02; C-7 Opt 03 C-5C Opt 02 C-5C Opt 04 | 122-0894-01 | 016-0359-01 | No adaptor*5 | 016-0269-03 |
| 1 cm Nonilluminated Graticule; 2213(A), 2215(A), 2235, 2236 | | | C-7 Opt 02 C-5C Opt 04 | 122-0894-01 | 016-0359-01 | No adaptor*5 | 016-0269-03 |
| ¼ inch Graticule i.e.;*4*12 305, 314, 326, 335, 336, 1501, 1502 | C-30B Opt 01*10 | C-30B Opt 01*10 | | | No adaptor | No adaptor*5 | 016-0327-01 |
| TM 500 i.e.; SC 502, SC 503, SC 504*4 | C-30B Opt 01*10 | C-30B Opt 01*10 | | | No adaptor | No adaptor*5 | 016-0327-01 |
| Nonilluminated Graticule;*8 2335, 2336, 2337 | | | C-7 Opt 02*8 C-5C Opt 04*8 | 122-0894-01 | | No adaptor*5 016-0359-01 | No adaptor |
| **Display Monitors** | | | | | | | |
| 8 cm x 10 cm*2*3 i.e.; 601, 602, 605, 606, 606B, 607 | | C-59A | C-4 Opt 02 C-5C; C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | 016-0249-06 | 016-0248-01 |
| Large Screen 10 x 12 cm i.e.;*1 603, 604, 608, 620, 624, 634 | | C-59A | C-4 Opt 02 C-5C; C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | 016-0249-06 | Not recommended |
| **Older 5 Inch Round***2 | | | | | | | |
| 502, 503, 504, 515, 516, 519, 530 & 540/550/580 Series, 575 | C-51*10 | C-53*10 | C-59A*10 | | No adaptor | 016-0225-04 | 016-0243-00 |
| **Older 5 Inch Rectangular** | | | | | | | |
| 560 Series i.e.;*2 561, 564, 567, 568 | | C-53*10 | C-59A*10 | | No adaptor | 016-0224-01 | 016-0244-00 |
| **Television Products** | | | | | | | |
| 380, 381 | | C-30B Opt 01*10 | | | No adaptor | No adaptor | 016-0327-01 |
| 520, 520A, 521, 521A, 522A*1*2 | | C-59A*10 | | | No adaptor | 016-0295-01 | No adaptor |
| 1480C | | C-53*10 | C-59A*9*10 | | No adaptor | 016-0342-00*9 | No adaptor |
| 528A*2, 1420, 1421, 1422, 1424*1*2 | | C-59A | C-4 Opt 02 C-5C; C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | 016-0249-06 | 016-0248-01 |
| 529*1 | | C-53*10 | | | No adaptor | 016-0224-01 | 016-0244-00 |
| 1740, 1741, 1742, 1750 | | C-30B Opt 01 | C-4; C-7 Opt 02; C-7 Opt 03 C-5C Opt 02; C-5C Opt 04 | 122-0894-01 | 016-0359-01 | No adaptor*5 | 016-0269-03 |
| **Spectrum Analyzers** | | | | | | | |
| 491*5 | C-30B | C-30B | | | No adaptor | No adaptor*5 | 016-0306-01 |
| 492, 492P, 494, 494P, 496, 496P*2 | | C-59A | C-4 Opt 02 C-5C; C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | 016-0249-06 | 016-0248-01 |
| **Others***6 | | | | | | | |
| 576, 5030, 5031 | | Only C-59(A)*10 | | | No adaptor | 016-0288-01 [C-59(A) only] | No adaptor |
| OF150, OF152 TDR | | | C-4 Opt 02 C-5C; C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | Not recommended | Not recommended |
| 1240*8 | | | C-4 Opt 02 C-5C; C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | Not recommended | Not recommended |
| T900 Series, excluding T922R, (see 7000 Series)*8 | | | C-5C Opt 03 C-7 Opt 04 | | 016-0358-01 | No adaptor*5 | No adaptor |

**1 Only cameras with <0.7 magnification can record the entire screen area of a 10 x 12 cm display.*

**2 These scopes do not have camera power. The C-51 and C-53 may be used only if powered with 016-0270-02 battery pack.*

**3 These scopes do not have illuminated graticules w/o mod.*

**4 Though these scopes do not have illuminated graticules the graticule may be photographed using storage flood guns on storage models.*

**5 Due to physical configuration the C-50 Family cannot be mounted.*

**6 For NON-Tek scopes contact your local Tek Field Office.*

**7 A corrector lens is required to increase cameras field of view so that the full 8 cm x 10 cm CRT display area can be recorded. The camera should be changed from standard to Option 01. To do this order 016-0301-01 for the standard C-30B or 016-0269-04 for the standard C-31B. These kits include the mounting adaptor and corrector lens.*

**8 These scopes have no CRT bezel, therefore a camera cannot be mounted. A hand held C-5C, C-7, or C-4 can obtain a record.*

**9 The C-59A may be used with 016-0224-01, however the image size is reduced.*

**10 Adaptor not included with camera. Order adaptor separately.*

**11 Use on scopes with graticule illumination or bistable storage.*

**12 Scopes do not have graticule illumination.*

## CAMERA COMPARISON CHART

| Camera | C-51 | C-53 | C-59A | C-30B | C-31B | C-5C | *NEW* C-4 | *NEW* C-7 |
|---|---|---|---|---|---|---|---|---|
| Features | Fastest writing speed<br>Adjustable film & shutter speed<br>Built-in view port<br>Single sweep mode<br>Remote shutter actuation<br>Interchangeable film backs | General purpose camera for 7000 Series scopes<br>Adjustable film & shutter speed<br>Built-in view port<br>Single sweep mode<br>Remote shutter actuation<br>Interchangeable film backs | General purpose camera for CRTs up to 6½ inches<br>Adjustable film & shutter speed<br>Built-in view port<br>Low cost<br>Interchangeable film backs<br>Internal batteries | Continuously variable magnification<br>Dual swing-away hinge for viewing the CRT<br>Easy operation<br>Interchangeable film backs<br>Compact size | Max writing speed for portable scopes<br>Dual swing-away hinge for viewing the CRT<br>Easy operation<br>Interchangeable film backs<br>Compact size | Low cost<br>Easy to use<br>Mounts on most scopes<br>Graticule illuminator<br>Viewing door<br>Fixed focus<br>OEM pricing available | Lowest Priced Tek Camera<br>Easy to use<br>Hand Held<br>Easily interchangeable hoods<br>Scope and Video hoods<br>Fixed focus<br>OEM pricing available | Motorized film back<br>Auto developing prints<br>Uses New Polaroid AutoFilms<br>Remote shutter activation<br>Audible Indicators<br>Fixed focus<br>OEM pricing available |
| Lens Aperatures | f/1.2 to f/11 | f/1.9 to f/16 | f/2.8 to f/16 | f/1.9 to f/16 | f/1.3 to f/16 | f/16 fixed | f/4.5 to f/32 | f/16 fixed |
| Magnification | 0.5 | 0.85 | 0.67 | Variable: 0.7 to 1.5 (0.8 w/Opt 01) | 0.5 (0.43 w/Opt 01) | 0.67 or 0.85 | 0.80*1, 0.70*1, 0.85*1 | 0.67 or 0.85 |
| Relative light gathering | 3.0 | 1.0 | 0.65 | 1.0 (0.9 w/Opt 01) | 2.7 (2.9 w/Opt 01) | 0.02 | 0.14 (0.85 mag)<br>0.15 (0.80 mag)<br>0.18 (0.70 mag) | 0.02 |
| Field of view with Polaroid pack (cm) | 8 x 10 | | 10.2 x 12.7 | 8 x 10 w/Opt 01, 7 x 9 std | 8 x 10 w/Opt 01, 7 x 9 std | 9.8 x 12.2 or 8 x 10 | 9.1 x 11.87 (std)*1<br>10.4 x 13.5 (Opt 02)*1<br>8 x 10 (Opt 03)*1 | 8.1 x 10.7 or 10.3 x 13.8 |
| Shutter Type | Electrical, 1/60 to 4 s (bulb, time, single sweep), remote shutter actuation, x-sync, scope "+ gate" input | | Mechanical, 1/125 to 1 s (bulb and time) x-sync | Mechanical, 1/125 to 1 s (bulb and time) x-sync | | Electrical, 1/10 to 5 s (time) | Mechanical, 1/125 s to 1 s (bulb), x-sync | Electronic Actuated 1/10 to 5 s, (Time Mode) |
| Film backs | Polaroid pack standard with "P" models, Graflok back standard with "G" models | | | Polaroid pack standard with "P" models, Graflok back available (016-0487-00) | | Polaroid pack Noninterchangeable | | Polaroid AutoFilm Noninterchangeable (CB-33) |
| Options | | | Adaptor frame & corrector lens kit for 576 & 5030, reduces magnification to 0.5, order 016-0288-01. | 01 Corrector lens has fixed magnification of 0.8; relative light gathering ability of 0.9; 8 cm x 10 cm field of view. Comes with mounting adaptor (016-0269-03) to accommodate 2400 and 400 Series scopes with 8 cm x 10 cm CRTs. | | See page 425 for specific selections | 01 (0.85 mag)<br>02 (0.80 mag)<br>03 (0.70 mag)<br>Video Hoods<br>11 (8.3 in diagonal)<br>12 (12.5 in diagonal)<br>See page 423 for specific selections | See Page 424 for specific selections |
| Optional Accessories | Mounting adaptors, battery pack (for C-51, C-53), writing speed enhancer (one for each model), Polaroid pack film back, Graflok 4 in x 5 in back and film holders, x-sync connector, carrying case. | | | Mounting adaptors, writing speed enhancer, Polaroid pack film back, Graflok 4 in x 5 in back and film holders, and carrying case x-sync cable, portra lens (for C-30B only) | | Mounting hood adaptors, flash unit, viewing door | Scope and video adaptor hoods, color filter kit (122-0909-00) | Foot switch, Mounting hood adaptors, flash unit, battery pack, 110 or 220 ac power supplies |

**1 Depends on which hood is used*

### CAMERA MOUNTING ADAPTOR AND HOOD PART NUMBER AND PRICES

016-0217-00 ..... **$95**
016-0223-01 ..... **$75**
016-0224-01 ..... **$75**
016-0225-04 ..... **$75**
016-0226-01 ..... **$78**
016-0228-01 ..... **$110**
016-0243-00 ..... **$90**
016-0244-00 ..... **$95**
016-0248-01 ..... **$85**
016-0249-06*1 ..... **$90**
016-0263-00 ..... **$90**
016-0269-03 ..... **$100**
016-0269-04*2 ..... **$100**
016-0295-01 ..... **$85**
016-0299-00 ..... **$95**
016-0301-01*3 ..... **$100**
016-0306-01*4 ..... **$90**
016-0327-01 ..... **$170**
016-0342-00 ..... **$230**
016-0357-01*5 ..... **$20**
016-0358-01*6 ..... **$20**
016-0359-01*7 ..... **$20**
122-0894-01*8 ..... **$45**
122-0896-01*9 ..... **$55**
122-0896-01*10 ..... **$55**

**1 Included with C-50 Series cameras.*
**2 Adaptor & lens included with C-31 B Option 01 cameras.*
**3 Adaptor & lens kit included with C-30B Option 01 cameras.*
**4 Included with Standard C-30B, C-31B Cameras.*
**5 Included with C-5C and C-5C Option 01 Cameras.*
**6 Included with C-5C Option 03 Cameras.*
**7 Included with C-5C Option 02 and Option 04 Cameras.*
**8 Included with C-4 (Standard)*
**9 Included with C-4 Opt 02*
**10 Included with C-4 Opt 03*

### POLAROID REPLACEMENT ROLLER ASSEMBLIES FOR PACK FILM BACKS

If your roller assembly is solid grey or two-tone grey. Order 401-0304-00 ..... **$26**

If your roller assembly is red and black. Order 401-0303-00 ..... **$26**

*Note: Because of mechanical differences, both roller assemblies are incompatible with each other's back.*

### ACCESSORIES FOR OLDER TEKTRONIX CAMERAS

**Polaroid Pack Film Back For Older Cameras: C-12, C-19, C-13, C-27**
These cameras are no longer produced by Tektronix. However due to customer need for a Pack Film Back these are now available. The Pack Film Back accepts the Polaroid pack film. Order 122-0671-01 ..... **$275**

**Mounting Adaptors**
C-12 to 7000 Series and 5000 Series. Order 016-0299-00 ..... **$95**

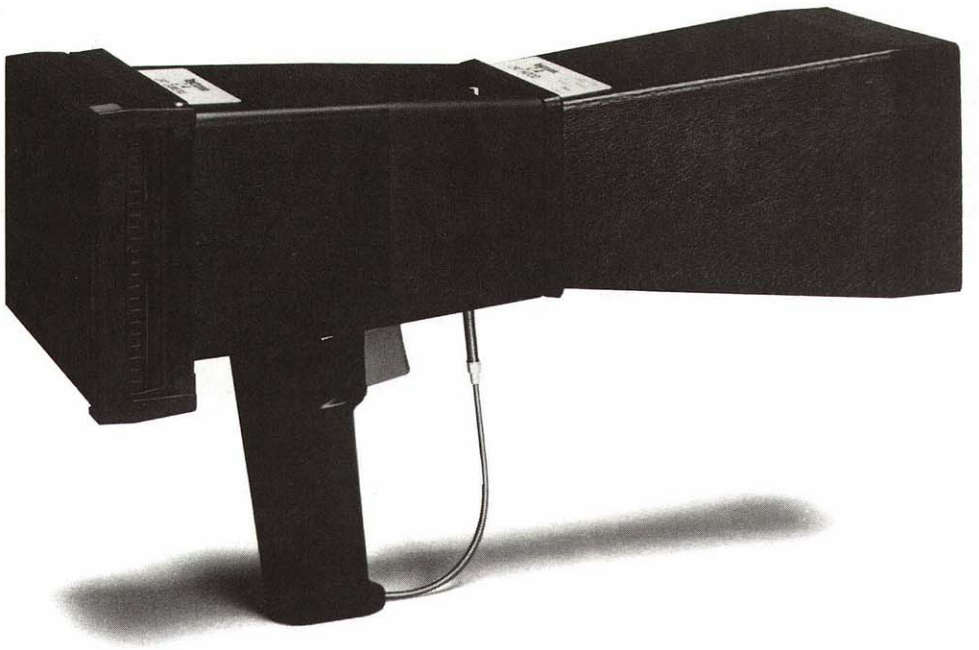
C-12 to 530, 540, 550 Series. Order 016-0226-01 ..... **$78**

C-12 to 560 Series rectangular CRTs. Order 016-0217-00 ..... **$95**

**Writing Speed Enhancer for C-12, C-27**
Provides controlled film fogging to increase writing speed by 3X for 3000 ASA film and >3.5X with 20,000 ASA film. Installs in minutes. Order 016-0280-02 ..... **$325**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

NEW



*Standard C-4 Hand-Held Camera*

## C-4

**Hand-Held Operation**

**Four Element f/4.5 Glass Lens System**

**Adapts to Most Tektronix and Non-Tektronix Scopes and CRT Displays**

**Five Easily Interchangeable Hoods**

**Two Large Hoods for Video Screens**

**Mechanical Shutter**

**No Focusing Required**

**OEM Pricing Available**

A camera can be a key part of your measurement system. It allows you to capture events, document the results, and it helps to *communicate* the results with clarity and credibility.

The *NEW* C-4 is a high quality CRT documentation camera at an affordable price. The C-4 is an easy-to-use hand-held camera system that uses Polaroid instant pack films which develop in seconds, giving you immediate results. The C-4 is ideal for the lab, classroom, medical facility, TV studio, or design bench. Two video hoods allow instant prints to be made from many common video CRTs.

### A Snap to Use

Anyone can take sharp, quality instant pictures after just a few minutes of familiarization with the camera and manual. No photographic skill or training is required!

### Portable

The C-4 is hand-held, thus easily moved between test locations without having to remove mounting hardware.

For easy handling, the contoured pistol grip includes a trigger button for the shutter release.

### Tektronix and Non-Tektronix Product Compatibility

The five easily interchangeable hoods allow the C-4 camera to fit most Tektronix and non-Tektronix oscilloscopes and CRT displays.

The C-4 is recommended for scopes with either illuminated graticules or bistable storage displays. On nonilluminated graticule scopes the C-4 will only record the waveform.*[1]

For Tektronix products compatibility see page 420.

For other Tektronix products not listed on page 420, and non-Tektronix oscilloscopes and CRT-based products, refer to mechanical and field of view compatibility below.

*[1] The Tektronix C-5C Camera, with flash, is recommended for scopes that do not have an illuminated graticlue.*

### Hood Selection

The hood is a key part of the C-4 system since it places the camera at the correct distance from the CRT screen, blocks out ambient light, and has a built-in corrector lens to properly focus the image and sets the magnification ratio. Each hood has two snap locks to insure quick interchangeability.

### Mechanical Compatibility

It is suggested that the hood's front lip dimensions be used as a guide when determining physical compatibility (see Adaptor Hood Selection Guide on page 423). Note: Hoods can fit around the CRT bezel or they can fit against the CRT's face, inside the bezel.

### Field of View Compatibility

Check to see that the hood selected provides a large enough field of view (how large a CRT display the camera will fully record). Refer to Scope Hood Selection Guide on the next page.

### CHARACTERISTICS

**Aperture** — f/32 to f/4.5 (continuously variable).

**Lens** — Four glass elements.

**Focal Length** — 105 mm nominal (without hood).

**Magnification** — Dependent on hood. Refer to Adaptor Hood Selection Guide on page 423.

**Relative Light Gathering, Ability** — See Adaptor Hood Selection Guide on page 423.

**Field of View** — Dependent on hood. Refer to Adaptor Hood Selection Guide on page 423.

**Shutter** — Mechanical $^1/_{125}$ s to 1 s bulb.

**Synchronization** — X-sync switch closure occurs when the shutter reaches its fully open position.

**PHYSICAL CHARACTERISTICS**

| Dimensions | mm | in |
|---|---|---|
| Width | 180 | 7.4 |
| Height (w/pistol grip) | 236 | 9.3 |
| Height(w/out pistol grip) | 119 | 4.7 |
| Depth w/std hood) | 363 | 14.3 |
| Depth w/out std hood) | 185 | 7.3 |
| **Weights ≈** | **kg** | **lb** |
| Net w/std hood | 1.0 | 2.1 |
| Net w/out std hood | 0.8 | 1.8 |

**INCLUDED ACCESSORIES**

Hood (user selected); operating manual.

### ORDERING INFORMATION

**C-4** Camera (Includes Body, Pistol Grip, and 122-0894-01 Hood.) ..... **$370**

**Option 01** — Body, Pistol Grip (No Hood) ..... **−$45**

**Option 02** — Body, Pistol Grip, and 122-0895-01 Hood ..... **NC**

**Option 03** — Body, Pistol Grip, and 122-0896-01 Hood ..... **NC**

**Option 11** — Body, Pistol Grip, and 122-0898-01 Hood ..... **+$34**

**Option 12** — Body, Pistol Grip, and 122-0899-01 Hood ..... **+$53**

**OPTIONAL ACCESSORIES**

**Split-Image Focus Plate** — Fits into the pack film back (with no film loaded, useful to determine if image is properly in focus and entirely within the camera's field-of-view. Order 387-0893-02 ..... **$4.00**

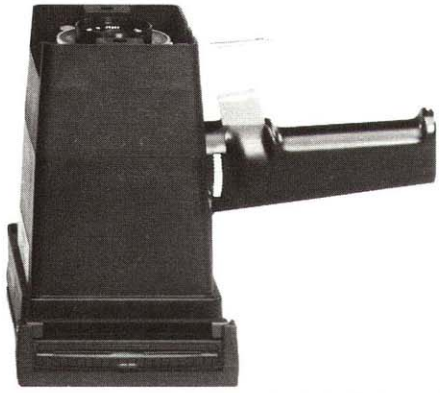
**Color Filter Kit** — Consists of 40.5 mm screw-in 85B filter, corrects the color film balance for most color CRT's. Order 122-0909-00 ..... **$13**

**Special pricing, terms and conditions are available to qualified OEMS. Contact your local Tektronix representative for complete information.**

CAMERAS

NEW

## C-4 WITH VIDEO HOODS



**C-4 SCOPE HOOD SELECTION GUIDE**

| | Scope Adaptor Hood | | | | | |
|---|---|---|---|---|---|---|
| | 122-0894-01 (with std C-4) | | 122-0895-01 (with Opt 02) | | 122-0896-01 (with Opt 03) | |
| Magnification w/C-4 | 0.8 | | 0.7 | | 0.85 | |
| Field of View*1 (cm) | 9.1 x 11.87 | | 10.4 x 13.5 | | 8.0 x 10.0*2 | |
| Relative Light Gathering | 0.15 | | 0.18 | | 0.14 | |
| **Diagonal*1** | | | | | | |
| | N/A | | N/A | | N/A | |
| **Front Lip*1 Dimensions** | **mm** | **in** | **mm** | **in** | **mm** | **in** |
| Width | 122*3 | 4.8*3 | 143*3 | 5.6*3 | 100*3 | 3.9*3 |
| Height | 108*3 | 4.2*3 | 132*3 | 5.2*3 | 80*3 | 3.2*3 |
| **Depth*1*5** | **mm** | **in** | **mm** | **in** | **mm** | **in** |
| | 178 | 7.2*2 | 206 | 8.1*2 | 171 | 6.8*2 |
| **Weights** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** |
| Net | 0.1 | 0.3 | 0.2 | 0.4 | 0.1 | 0.3 |
| Hood Price Only | **$45** | | **$55** | | **$55** | |

**C-4 VIDEO HOOD SELECTION GUIDE**

| | Video Hood | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 122-0898-01 (with Opt 11) | | | | 122-0899-01 (with Opt 12) | | | |
| Magnification w/C-4 | 0.55 | | | | 0.35 | | | |
| Field of View*1 (cm) | N/A | | | | N/A | | | |
| Relative Light Gathering | N/A | | | | N/A | | | |
| **Diagonal*1** | **Inside** | | **Outside** | | **Inside** | | **Outside** | |
| | **mm** | **in** | **mm** | **in** | **mm** | **in** | **mm** | **in** |
| | 211 | 8.3 | 213 | 8.4 | 318 | 12.5 | 323 | 12.7 |
| **Front Lip*1 Dimensions** | **Inside** | | **Radii*6** | | **Inside** | | **Radii*6** | |
| | **mm** | **in** | **mm** | **in** | **mm** | **in** | **mm** | **in** |
| Width | 168*3 | 6.6*3 | 660 | 26.0 | 262*4 | 10.3*4 | 559 | 22.0 |
| Height | 127*3 | 5.0*3 | 660 | 26.0 | 186*4 | 7.3*4 | 559 | 22.0 |
| **Depth*1*5** | **mm** | | **in** | | **mm** | | **in** | |
| | 257 | | 10.1*5 | | 404 | | 15.9*5 | |
| **Weights** | **kg** | | **lb** | | **kg** | | **lb** | |
| Net | 0.3 | | 0.7 | | 0.6 | | 1.4 | |
| Hood Price Only | **$79** | | | | **$98** | | | |

*1 Nominal dimensions.

*2 Image size is limited by front opening of the hood.

*3 For outside dimensions add 0.30 cm (0.12 in) to each value. Each wall thickness nominally is 0.15 cm (0.06 in).

*4 For outside dimensions add 0.14 in to each value. Each wall thickness nominally is 0.07 in.

*5 From mounting surface to front lip.

*6 To fit the curvature of the CRT's.

**C-4 VIDEO COMPATILIBITY CHART**

Ths following lists compatibility currently tested. Please refer page 422 for determining compatibility on products not listed.

| DISPLAY | C-4 VIDEO HOOD |
|---|---|
| Tektronix: 4105, 4107 | Option 12 |
| Ann Arbor Ambassador *1*4 | Option 12 |
| Apple II Monitor G0905 | Option 11 |
| Apple MacIntosh Display | Option 11 |
| Compac "Plus"*2 | Option 11 |
| DEC VR-241*1 | Option 12 |
| DEC MATE II VR-201A*2*3*4 | Option 12 |
| Heathkit H-19*2 | Option 12 |
| IBM PC Jr. Monitor 4863*1 | Option 12 |
| IBM Color PC Monitor 5153 | Option 12 |
| IBM PC Portlable | Option 11 |
| NEC JB-1201M Monitor | Option 12 |
| Panasonic TR-903 Monitor | Option 11 |
| Quad Chrome Color Monitor | Option 12 |
| Sony KV1217 Color Monitor | Option 12 |
| Tandy Color Monitor 16-230 | Option 11 |
| Zenith ZVM-122*2 | Option 11 |
| Zenith ZVM-121*2*4 | Option 12 |
| Zenith ZVM-135 | Option 12 |

*1 Cuts off some of the CRT.

*2 Tends to have soft focus.

*3 Possible light leaks since CRT has less curveature than the hood.

*4 Optical distortion more noticeable.

Note: Will not work on:
- Tek: 4025, 4027, or 4050 Series.
- Tandy Computers with built-in CRTs.
- Apple IIc Monitor A2M2010.

NEW

STD C-7

## C-7

**Motorized Back, Snap-on Print Holder**

**Automatic Print Ejection and Processing**

**Three New Integral Polaroid AutoFilms:**

- **Black and White Print with Extended Grey Scale (Like Type 611) (200 ASA)**
- **Black and White High Resolution Negative Transparency (100 ASA)**
- **High Speed Color Print (640 ASA)**

**Ten Exposures Per Pack**

**Fixed Focus**

**Remote or Manual Shutter**

**Uses C-5C Camera Hoods**

**Audible Indicators**

**Protective Circuitry for Power in and Ejection Operations/Battery or Ac Power**

**Graticule Flash on Some Versions**

**OEM Pricing Available**

The C-7 general purpose CRT camera incorporates a motorized Polaroid instant film system which eliminates the need to pull, peel, and time the prints. The print automatically ejects after each exposure and self develops in about 60 seconds. The prints can be held in the snap-on print holder.

With only one control (shutter speed) to adjust, the C-7 is easy to use. The fixed-focus f/16 lens system delivers sharp prints, and the reliable electronic shutter makes accurate exposures possible. Protective features include a voltage regulation, overcurrent foldback protection, over and under voltage warning (buzzer), and under voltage eject shutdown.

### Features

The camera can be operated by the manual shutter or by a remote switch via the remote shutter input jack. An audible beep occurs after the last exposure, and also after each exposure when the input voltage is low.

### Polaroid AutoFilms

The Tektronix C-7 Camera System uses three new Polaroid AutoFilms: Type 331 is a black-and white extended grey-scale film for video image recording, providing prints that reproduce the full range of black-and-white densities displayed on video monitors. AutoFilm Type 336 is a high resolution instant film for creating black-and-white negative transparencies. High Speed Color AutoFilm Type 339 produces professional-quality positive color reproductions of CRT color screens. (The color film provides a print with a reversed or mirror image unless the CRT screen image is electronically reversed before making the exposure.) AutoFilm prints and transparencies offer large four-by-three inch image areas. Containing ten exposures each, the film packs have no internal batteries as consumer Polaroid films.

*Presently there is no high-speed, high contrast film available, therefore the C-7's applications on scopes may be slightly limited. (Faster film(s) may be available from Polaroid in late 1985.)*

**Film is available from Polaroid 1-(800)-225-1618 or their professional dealers (see page 419 for camera specifications).**

### Product Compatibility

The C-7 camera can be mounted on most models of Tektronix oscilloscopes and small monitors, using the same hoods as the C-5C. See page 420 for compatibility chart.

The standard C-7 comes complete with a hood, print holding chamber, a CRT viewing door, and a graticule flash unit.

### CHARACTERISTICS

**Relative Aperture** — Fixed at f/16.
**Magnification Factor** — 0.67 or 0.85.
**Lens** — Three glass elements.
**Relative Light-Gathering Ability** — 0.02
**Field of View (Nominal)** — 8.1 cm x 10.7 cm (0.85 mag) or 10.3 cm x 13.8 cm (0.67 mag).
**Shutter** — Electronic Actuated: 1/10 to 5 s, open shutter mode.
**Remote Shutter Jack** — TTL compatible (uses 0.101 DIA, Micro Series plug, i.e., Switch Craft part #850).
**Film Back Recycle Time** — ≈4 s between shots.
**Audible Indicators (Buzzer)** — Out-of-Film Warning: After tenth print is ejected, buzzer will sound for approximately one second. Low or High Voltage Warning: Buzzer will sound during the film-eject cycle when the batteries start to get weak.

#### POWER REQUIREMENTS

**Voltage** — 8 V to 12 V. (Can be jumpered for 5 V to 12 V.)
**Current** — ≈1 mA idle, 3 A for 10 s maximum.
**Mechanical Interface** — Lemo type connector. Pin 1: + supply. Pin 3: − supply.

#### POWER SUPPLIES (OPTIONAL)

**110 V** — Output Voltage: 9.5 V nominal. Output Current: 1.5 A nominal, 3 A peak. Line Voltage: 90 V ac to 132 V ac, 50 Hz to 60 Hz nominal.
**220 V** — Output Voltage: 9.5 V nominal. Output Current: 1.5 A nominal, 3 A peak. Line Voltage: 180 V ac to 250 V ac, 50 Hz to 60 Hz nominal.
**Battery Pack** — Number of Cells: Eight. Type of Cells: Alkaline or NiCad AA. (Batteries not included.)

#### PHYSICAL CHARACTERISTICS

| Camera Dimensions ≈ | mm | in |
|---|---|---|
| Width | 180 | 7.1 |
| Height w/o Chamber | 147 | 5.8 |
| Height with Chamber | 264 | 10.4 |
| Depth | 251 | 9.9 |
| **Weights ≈** | **kg** | **lb** |
| Net | 1.3 | 3.7 |
| Shipping | 2.6 | 5.8 |

**Hoods C-5C** — Uses C-5C adaptor hoods. Refer to hood front lip dimensions on page 425.

#### INCLUDED ACCESSORIES

Print holding chamber (122-1039-00); operators manual.

### ORDERING INFORMATION

C-7 requires a power source (does not come as a standard accessory). Order Opt 30, Opt 31, or Opt 32 or your own power via Lemo connector.

**C-7** W/016-0357-01 Hood and Flash ..... **$615**
**Option 01** — 016-0357-01 Hood and w/o Flash ..... −**$30**
**Option 02** — 016-0359-01 Hood and Flash ..... **NC**
**Option 03** — 016-0359-01 Hood and w/o Flash ..... −**$30**
**Option 04** — 016-0358-01 Hood and Flash ..... **NC**
**Option 05** — 016-0358-01 Hood and w/o Flash ..... −**$30**
**Option 20** — Camera Body Only, w/o Flash or Hood .. −**$20**
(NOTE: All cameras come with a print holding chamber.)
**Option 30** — With 016-0799-01 Battery Pack (batteries not included) ..... +**$20**
**Option 31** — W/ac Power Supply (110 V) ..... +**$50**
**Option 32*1** — With Power Supply (220 V) ..... +**$55**
**1 Requires a power cord (not included) which will have the correct plug for the particular country. See below.*

#### INTERNATIONAL POWER CORDS
**(Required for 220 V Ac Power Supply)**

Universal Euro 220 V/16 A, 50 Hz. Order 161-0066-09 . **$9.00**
UK 240 V/13 A, 50 Hz. Order 161-0066-10 ..... **$18.75**
Australian 240 V/10 A, 50 Hz. Order 161-0066-11 ..... **$8.25**
Switzerland 220 V/10 A, 50 Hz. Order 161-0154-00 ..... **$12**

#### OPTIONAL ACCESSORIES

**Extra Print Holding Chamber** — Order 122-1039-00 .. **$5.00**
**Foot Switch with 8 ft Cable** — Order 260-1189-02 ... **$22.50**
**Extra Battery Pack with Lemo Connector** — Order 016-0799-01 ..... **$20**
**Lemo Connector for Power-In** — Order 131-0778-00 . **$12.50**
**Extra Ac Power Supply with Lemo Connector and a 5½ ft Length Cable** —For 110 V ac 50 Hz to 60 Hz. Order 119-1847-02 ..... **$50**
For 220 V ac 50 Hz to 60 Hz. Order 119-1847-03*1 ..... **$55**
**1 Requires power cord, see above.*

**FOR ADDITIONAL HOODS, GRATICULE FLASH UNIT, OR LARGE VIEWING DOOR SEE C-5C OPTIONAL ACCESSORIES SECTION ON PAGE 425.**

CAMERAS

*Standard C-5C (with flash).*

*C-5C Option 01 (with large viewing door).*

## C-5C

**Low Cost**

**Covers 8 cm x 10 cm or 9.8 cm x 12.2 cm CRT Displays**

**Easy to Use**

**Mounts Onto Many Scopes and CRT-Based Instruments**

**Fixed Focus**

**Lightweight and Compact**

**Interchangeable Adaptor Hoods**

**Built-In Flash on Some Models**

**OEM Pricing Available**

### Maximum Performance at Minimum Cost

If your application does not required specialized photographic techniques, such as the capability to record single sweeps, this general purpose camera may fill your needs at a low cost. The C-5C is lightweight and modular, with a reliable electronically activated shutter. The three-element f/16 lens offers both 0.67 and 0.85 magnifications, either of which you can easily change by reversing the lens/shutter module and the spacer module positions.

### Flash

A variable-intensity xenon flash that evenly lights CRTs with nonilluminated graticules comes on the C-5C and Options 03 and 04. It can be easily retrofitted on C-5C's that do not have it.

### Viewing Door

Flash models have a small built-in door. Nonflash models replace the flash unit with a large lift-up viewing door (016-0630-00).

### Adaptor Hoods

Comes standard with camera (chart on right), and they can be ordered separately. Easily changed by removing four screws inside hood.

### Film

Uses Polaroid pack film, i.e., 667, 665 etc.

Note: The C-5C and C-7 are separate camera systems, therefore a C-5C cannot be converted into a C-7 and vise versa. However, they do use the same hoods and flash assemblies.

### OEM Quantities

The low-cost C-5C Oscilloscope Camera is available in OEM quantities.

**Special pricing, terms and conditions are available to qualified OEMs. Contact your local Tektronix representative for complete information.**

### CHARACTERISTICS

**Aperture** — Fixed at f/16.
**Lens** — Three glass elements.
**Magnification** — 0.67 and 0.85.
**Relative Light-Gathering Ability** — 0.02.
**Shutter** — Electronic; 1/10 to 5 s; time.
**Field of View** — 9.8 cm x 12.2 cm (0.67 magnification) or 8.0 cm x 10.0 cm (0.85 magnification).
**Power** — The C-5C requires (4) AA alkaline batteries (not included). Battery holder inside camera.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 168 | 6.6 |
| Height | 140 | 5.5 |
| Depth | 257 | 10.1 |
| **Weights ≈** | **kg** | **lb** |
| Net | 1.4 | 3.0 |
| Shipping | 1.9 | 4.1 |

### ADAPTOR HOOD FRONT LIP DIMENSIONS*1

| | Adaptor Hood | | | | | |
|---|---|---|---|---|---|---|
| | 016-0357-01 | | 016-0358-01 | | 016-0359-01 | |
| **Dimensions** | **cm** | **in** | **cm** | **in** | **cm** | **in** |
| Height | | | | | | |
| Inside | 13.0 | 5.13 | 9.5 | 3.74 | 10.5 | 4.13 |
| Outside | 13.7 | 5.38 | 11.2 | 4.41 | 11.2 | 4.40 |
| Width | | | | | | |
| Inside | 14.2 | 5.60 | 11.8 | 4.65 | 12.0 | 4.74 |
| Outside | 14.9 | 5.85 | 13.1 | 5.14 | 12.7 | 4.99 |

**1 All dimensions are approximate since each hood has additional plastic for notches and grooves for mounting.*

### OPTIONAL ACCESSORIES

**Large Viewing Door** — Fits all three mounting adaptor hoods. Included with C-5C Options 01 and 02. Order 016-0630-00 ..... **$7.00**

**Graticule Flash Unit** — Fits all three mounting adaptor hoods. Included with C-5C and C-5C Options 03 and 04. Order 016-0642-00 ..... **$150**

**Additional Mounting Adaptor Hoods** — (Requires flash unit or large viewing door.)

For C-5C and C-5C Option 01. Order 016-0357-01 ..... **$20**

For C-5C Options 02 and 04. Order 016-0359-01 ..... **$20**

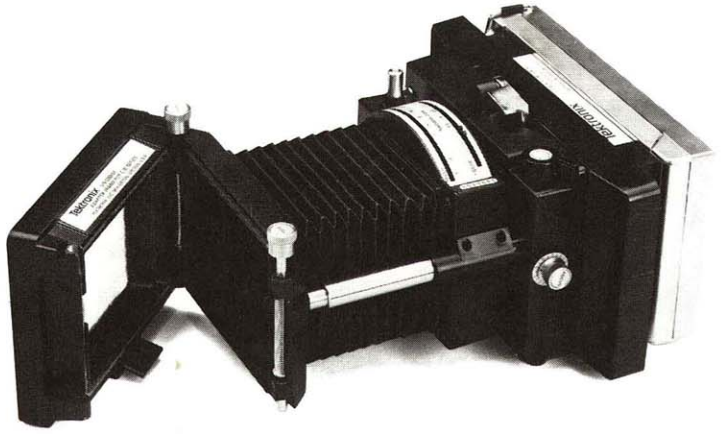
For C-5C Option 03. Order 016-0358-01 ..... **$20**

### ORDERING INFORMATION

| Order | For Use With: (see page 421 for other instruments) | Camera Comes Standard With: Adaptor Hood Part Number*1 | Flash Unit*2 | Large Viewing Door*3 | Price |
|---|---|---|---|---|---|
| C-5C | 577, 600 Series with unilluminated graticule 1420 Series, 5100 Series | 016-0357-01 | Yes | No | **$495** |
| C-5C Option 01 | 528, 600 Series without graticule, or with illuminated graticule, 5400 Series, 7000 Series, T922R TELEQUIPMENT D83 | 016-0357-01 | No | Yes | **−$30** |
| C-5C Option 02 | 432, 434, 455, 464, 465B, 465M, 466, 468, 475, 475A 2400 Series | 016-0359-01 | No | Yes | **−$30** |
| C-5C Option 03 | T900 Series except T922R | 016-0358-01 | Yes | No | **NC** |
| C-5C Option 04 | 2200 Series with unilluminated graticule | 016-0359-01 | Yes | No | **NC** |

**1 Additional hoods available. Check if a flash or large viewing door is required.*
**2 Small viewing door built into flash unit.*
**3 016-0630-00 (large viewing door).*

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**



C-31BP

## C-30 Series

**Standard Models Cover 0.8 cm/Div CRTs**

**Adaptable to Many Instrument Types**

**Option 01 Optimized for 8 cm x 10 cm CRTs**

**Continuously Variable Magnification (C-30B)**

**Reduced Image Size on C-31B (0.5 Mag)**

**Interchangeable Backs**

**Swings Away for CRT Viewing**

The standard C-30B and C-31B models are primarily designed for use on the older 400 Series portables that have 0.8 cm/div CRT. (Mounting adaptor, 016-0306-01, is included.)

The Option 01 models are the same cameras except that a slip-on corrector lens is used for coverage of 8 cm x 10 cm displays, and a different mounting adaptor (016-0269-03 for 2400 Series, 465, etc.) is included.

The C-30B/C-31B Series of cameras can be used on some 7000 and 5000 Series lab scopes (with 8 cm x 10 cm display), 300 Series Sony/Tek portables, as well as 600 Series monitors. See Camera Selection Guide on page 420 for compatibility information.

Dual swing-away hinges allow the camera to be swung out of the way, either to the left or right, for direct viewing of the CRT. The cameras are focused, using a split-image focus plate placed inside the Polaroid back. Graflok back cameras use the back's (Graflok) built-in viewing glass.

## C-30B

The C-30B is a versatile, general purpose camera for scopes that have 0.8 cm/div CRTs. The C-30B offers a highly reliable mechanical shutter and an f/1.9 lens. It is the only Tektronix oscilloscope camera that features continuously variable magnification (from 0.7 to 1.5) giving you greater photographing flexibility. This camera was designed for the 453, 454, 485 and 491.

## C-30B Option 01

The C-30B Option 01 offers an expanded field of view. The f/1.9, 0.8 magnification lens covers an 8 cm x 10 cm CRT screen without vignetting. The relative light-gathering ability is 0.9. This camera is recommended for the 2400 Series, 455, 464, 465, 465B, 466, 468, 475, and 475A oscilloscopes.

NOTE: The C-30B in/corrector lens is optimized for 0.8 mag only.

### C-30B CHARACTERISTICS

Specifications are the same for the C-30B and C-30B Option 01 unless otherwise noted.

**Aperture** — Variable from f/1.9 to f/16.
**Magnifications** — Variable from 0.7 to 1.5, (0.8 magnification on Option 01 with C-30B set to 1.0 magnification).
**Relative Light-Gathering Ability** — 1.0 (0.9 on Option 01).
**Shutter** — Mechanical, 1/125 to 1 s; bulb and time.
**Synchronization** — X-sync contact closure.
**Field of View** — 7.0 cm x 9.0 cm. Option 01: 8.0 cm x 10.0 cm.

PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 191 | 7.5 |
| Height | 130 | 5.1 |
| Depth | 254 | 10.4 |
| **Weights ≈** | **kg** | **lb** |
| Net | 2.2 | 4.8 |
| Shipping | 4.1 | 9.0 |

## C-31B

This camera's f/1.3, 0.5 magnification lens offers the fastest writing speed for 2400 and 400 Series oscilloscopes. The 0.5 magnification means that the image size on the print will be approximately one half of the C-30B's. The C-31B is for 0.8 cm/div CRTs (453, 485, 491, 454).

## C-31B Option 01

The C-31B Option 01 offers an expanded field of view. This f/1.2, 0.5 magnification lens has a relative light-gathering ability of 2.9 covering CRT screens up to 8 cm x 10 cm. It is recommended for the 2400 Series, 455, 464, 465, 465B, 466, 468, 475, and 475A oscilloscopes.

### C-31B CHARACTERISTICS

Specifications are the same for the C-31B and C-31B Option 01 unless otherwise noted.

**Aperture** — Variable from f/1.3 to f/16.
**Lens Speed** — f/1.3
**Magnification** — 0.5 (0.43 on Option 01).
**Relative Light-Gathering Ability** — 2.7 (2.9 on Option 01).
**Shutter** — Mechanical; 1/125 to 1 s; bulb and time.
**Synchronization** — X-sync contact closure.
**Field of View** — 7 cm x 9 cm. Option 01: 8 cm x 10 cm.

PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 231 | 9.1 |
| Height | 140 | 5.5 |
| Depth | 269 | 10.6 |
| **Weights ≈** | **kg** | **lb** |
| Net | 3.1 | 6.8 |
| Shipping | 5.4 | 11.0 |

### INCLUDED ACCESSORIES (C-30B, C-31B)

**STANDARD**

Polaroid pack film back (122-0752-02); split-image focus plate (387-0893-02); mounting adaptor (016-0306-01); instruction manual.

**OPTION 01**

Polaroid pack film back (122-0752-02); split-image focus plate (387-0893-02); C-30B corrector lens (352-0341-01) or C-31B corrector lens (122-0980-00); mounting adaptor (016-0269-03); instruction manual.

### ORDERING INFORMATION

"P" denotes that the camera has a 3 in x 4 in pack film back.

**C-30BP** Camera ..... **$1,445**
**Option 01** — Expanded field of view ..... **+$44**
**C-31BP** Camera ..... **$1,670**
**Option 01** — Expanded field of view ..... **+$44**
All models include Polaroid pack film back.

### CONVERTING OPTION 01 MODEL TO STANDARD MODEL

The Option 01 versions of the C-30B and C-31B Cameras can be converted to standard models by simply slipping off the corrector lens, removing the mounting adaptor, and adding an 016-0306-01 mounting adaptor. Refer to pages 420-421 for compatibility and price.

### CONVERTING STANDARD MODEL TO OPTION 01 MODEL

A standard-model C-30B or C-31B can be converted to an Option 01 model by means of a conversion kit which contains a mounting adaptor (016-0269-03) plus the appropriate corrector lens (see Option 01's "Included Accessories").
Standard C-30B to Option 01. Order 016-0301-01 ..... **$100**
Standard C-31B to Option 01. Order 016-0269-04 ..... **$100**
Refer to pages 420-421 for prices and compatibility.

### C-30 SERIES OPTIONAL ACCESSORIES

**Mounting Adaptors** — See page 420.
**Writing Speed Enhancer** — Increases effective film speed about 3X for 3000 speed film. Now supports 20,000 ASA (612) film. Installs in minutes. Order 016-0284-02 ..... **$280**
**Polaroid Pack Film Back** — Accepts Polaroid 3 in x 4 in pack film. Included with "P" models. (Focus plate included.) Order 122-0752-02 ..... **$185**
**Split-Image Focus Plate** — Included with "P" models. Order 387-0893-02 ..... **$4.00**
**Graflok Type 4 in x 5 in Back** — Accepts Polaroid Land 4 in x 5 in film holders, standard cut film holders, filmpack adaptors, roll film holders (except heavy motorized roll film holders). Order 016-0487-00 ..... **$250**
Refer to page 428 for film holders which are required for operation.
**Carrying Case** — Molded high-impact plastic case with polyurethane foam liners to protect your camera in transit. 18.5 in x 14.5 in x 8 in. Order 016-0587-00 ..... **$120**
**X-Sync Cable** — Order 012-0364-01 ..... **$25**
**Portra Lens** — A slip-on auxiliary lens which extends the focus distance of the camera so it can be used for off-scope photography of scenes such as test set-ups. At a maximum distance of 21 in the camera covers 19 in x 21 in. Usable with either the C-30B or C-30B Option 01(but not with the C-31A or C-31B). Order 016-0246-02 ..... **$35**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

C-51G

C-53P

## C-50 Series Features

**Electronic-Actuated Shutter (C-51, C-53)**

**Photometer Exposure Aid**

**Range-Finder Focusing**

**Interchangeable Film Backs**

**Swings Away from Scope**

### The Top of the Line

The three C-50 Series cameras are designed for use with all Tektronix 7000 Series oscilloscopes, and can be adapted to fit most 5000 Series oscilloscopes as well as other Tek instruments. Full selection of film backs, and adjustable film and shutter speeds give you the flexibility you need to best record your measurements. The photometer exposure aid, similar to light meters used in conventional photography, provides an easy way to approximate the correct exposure for repetitive or stored traces. X-sync connectors allow the camera shutter to trigger the event. And each camera's built-in viewing tunnel lets you see what's on the display when the camera is in place.

The camera shutter (C-51 and C-53) is electrically actuated through a shutter actuator circuit by a pushbutton, or remotely through a remote input connector. Both the pushbutton and remote input connector are located on the control panel.

When the C-50 Series camera is used with the Tektronix 7000 Series oscilloscopes, a three-pin connector in the oscilloscope bezel applies power to the camera and receives from the camera a pulse for resetting the oscilloscope sweep when the oscilloscope and camera are both in single-sweep modes. Also, when the oscilloscope and camera (C-51 and C-53 only) are in the single-sweep mode, the "+ gate" output from the oscilloscope can be applied to the "+ gate" input connector on the camera to close the shutter five seconds after the end of the oscilloscope sweep.

**The C-51 and the C-53 are available in ruggedized versions. Contact your Tektronix Field Office for further details.**

## C-51

**Fastest Writing Speed**

**Automatic Single Sweep Mode**

**Reduced Image Size (0.5 Mag)**

This camera offers the fastest writing speed of any Tektronix oscilloscope camera. The f/1.2 lens shoots images at 0.5 magnification, clearly capturing fast transients or single sweeps, although at some expense to image size. The C-51's electric shutter can operate at speeds ranging from 1/60 to 4 seconds, and offers bulb, time, and single sweep modes by manual or remote control.

### CHARACTERISTICS

**Aperture** — Variable from f/1.2 to f/16.

**Magnification** — 0.5.

**Relative Light-Gathering Ability** — 3.0.

**Shutter** — Electric; 1/60 to 4 s, bulb, time, and single sweep modes, manual or remote control. Scope's "+ gate" is used for shutter actuation.

**Power Requirement** — +15 V from 7000 Series oscilloscopes, or an optional battery pack for non-7000 Series instruments (see next page).

**Synchonrization** — X-sync switch closure.

**Field of View** — 8 cm x 10 cm (with pack film).

PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 248 | 9.8 |
| Height | 292 | 11.5 |
| Depth | 273 | 10.8 |
| **Weights ≈** | **kg** | **lb** |
| Net | 4.3 | 9.5 |
| Shipping | 6.8 | 15.0 |

## C-53

**Medium Speed**

**General Purpose Camera**

**Automatic Single Sweep Mode**

The C-53, like the C-51, provides an 8 cm x 10 cm field of view when used with Polaroid pack film. Its f/1.9 lens and 0.85 magnification, however, offer somewhat slower writing speed. This camera's electric shutter also offers speeds ranging from 1/60 to 4 seconds, and can be operated manually or remotely in bulb, time, or single sweep mode.

### CHARACTERISTICS

**Aperture** — Variable from f/1.9 to f/16.

**Magnification** — 0.85.

**Relative Light-Gathering Ability** — 1.0.

**Shutter** — Electric; 1/60 to 4 s, bulb, time, and single sweep modes, manual or remote control. Scope's "+ gate" is used for shutter actuation.

**Power Requirement** — +15 V from 7000 Series oscilloscopes, or an optional battery pack for non-7000 Series instruments (see next page).

**Synchronization** — X-sync switch closure.

**Field of View** — 8 cm x 10 cm (with pack film).

PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 191 | 7.5 |
| Height | 292 | 11.5 |
| Depth | 273 | 10.8 |
| **Weights ≈** | **kg** | **lb** |
| Net | 2.4 | 7.5 |
| Shipping | 5.4 | 12.0 |

**For Ordering Information see next page.**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

C-59AP

## C-59A

**For Larger CRT'S**

**Mechanical Shutter**

**Low-Cost**

**Photometer Exposure Aid**

**Range-Finder Focusing**

**Internal Battery or External Power**

This camera is designed for CRTs up to 6½ inches, and has a 10.2 cm x 12.7 cm field of view with Polaroid pack film. With the use of an adaptor frame/corrector lens optional accessory, the camera's field of view can be expanded to fully cover the 6½ inch CRT and adjacent scale readout characters of the Tektronix 576 Curve Tracer and the 5030 Series oscilloscopes. It is the only C-50 Series camera for the 7603. Many of the features of the high-priced C-50 Series cameras are standard on the C-59A: photometer exposure aid, range-finder focusing, bulb and time operating modes, x-sync contacts, and film back interchangeability.

### CHARACTERISTICS

**Aperture** — Variable from f/2.8 to 1/16.

**Magnification** — 0.67.

**Relative Light-Gathering Ability** — 0.65.

**Shutter** — Mechanical; 1/125 to 1 s; bulb and time.

**Synchronization** — X-sync switch closure.

**Field of View** — 10.2 cm x 12.7 cm (wider with optional 016-0288-01 adaptor frame/corrector lens).

**Power Requirement** — Receives power (+15 V) from a 7000 Series oscillsocope, or from an internal battery pack, 12 AA size alkalines, (12 V) if used on a non-7000 Series oscilloscope.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 193 | 7.7 |
| Height | 292 | 11.5 |
| Depth | 273 | 10.8 |
| **Weights ≈** | **kg** | **lb** |
| Net | 3.2 | 7.0 |
| Shipping | 5.0 | 11.0 |

### INCLUDED ACCESSORIES (C-50 SERIES)

Mounting adaptor for all 7000, 5000, and small 600 Series (016-0249-06); camera visor (337-0411-02); "P" models include focus plate (387-0893-02); instruction manual. Polaroid pack film back (122-0926-02). "G" models include Graflok film back (122-0931-01) with integral focusing screen.

C-59 does not include 8 AA size alkaline batteries.

### ORDERING INFORMATION

**"P" Models accept only Polaroid pack film.**

**"G" Models have A Graflok type back that requires A film holder (see next column).**

**C-51 CAMERA**

**C-51G ..... $2,300**

**C-51P ..... $2,300**

**C-53 CAMERA**

**C-53P ..... $1,900**

**C-59A CAMERA**

**C-59AG ..... $1,315**

**C-59AP ..... $1,315**

**C-59A Adaptor Frame with Corrector Lens Kit** — Expands the field of view to fully cover the 6½ inch CRT and adjacent scale readout characters of the 576 Curve Tracer and 5030 Series oscilloscopes. The slip-on corrector lens (352-0293-00) reduces the effective magnification of the C-59 from 0.67 to 0.5 so it can record the entire display on Polaroid 3¼ in x 4¼ in film (for the C-59A camera only). Adapts camera to 576, 5030, and 5031. Order 016-0288-01 ..... **$140**

### C-50 SERIES OPTIONAL CAMERA ACCESSORIES

**Mounting Adaptors** — See table on page 420.

**Battery Pack** — Provides auxiliary +15 V power source for using the C-51, C-53 Cameras with oscilloscopes without camera power. A three-position mode switch on the battery pack also allows the camera to be powered from a 7000 Series oscilloscope or an external +15 V source. Includes three pin female connectors for external power in (131-0716-00). Net weight, including batteries, is 1.2 lb. Requires 12 AA size alkaline batteries (not included). Order 016-0270-02 ..... **$275**

**Writing Speed Enhancer** — Provides controlled film fogging to increase writing speed by 3X for 3000 ASA film and ≥3.5X with 20,000 ASA film. Installs in minutes.
For C-51 Order 016-0279-02 ..... **$255**
For C-53 Order 016-0300-02 ..... **$280**
For C-59A Order 016-0290-02 ..... **$300**

**X-Sync Connector Plug** — Not shown. Order 134-0079-00 ..... **$1.30**

**Carrying Case** — Hold a complete C-50 Series camera with extra film backs and accessories. Order 016-0177-00 ... **$285**

**Polaroid Pack Film Back** — Included with "P" models. Order 122-0926-02 ..... **$175**

**Focus Plate** — Included with "P" models. Order 387-0893-02 ..... **$4.00**

**Graflok Type Film Back** — Included with "G" models, accepts Polaroid 4 in x 5 in film holder, standard cut-film holders, film-pack adaptors, roll-film holders*[1] (except heavy motorized models). Includes integral focusing screen. Order 122-0931-01 ..... **$250**

### OPTIONAL FILM HOLDERS FOR GRAFLOK TYPE BACKS ("G" MODELS ONLY)

Cameras with Graflok type backs must have a film holder in order to be functional.

Here are several holders*[1] that allow the use of roll film, or 4 in x 5 in Polaroid films. Order these holders from Tek, the manufacturer, or from your local camera store.

**Polaroid Land #545 4 in x 5 in Film Holder** — For Polaroid 4 in x 5 in Single Exposure Film Packets. Order 016-0201-01 ..... **$285**

**RH/10 120 Roll-Film Holder** — Ten exposures 2¼ in x 2¾ in for 4 in x 5 in Graflok Backs. Order 122-0736-01 ..... **$360**

**RH/50 70 mm Holder** — Fifty exposures, 2¼ in x 2¼ in for 4 in x 5 in Graflok Backs only. Order 122-0967-00 ..... **$275**

Roll film holders are also manufactured by several other companies.

*[1] *Other film holders and adaptors (4 cm x 5 cm cut film, pack film, or roll film) are available at local camera store.*

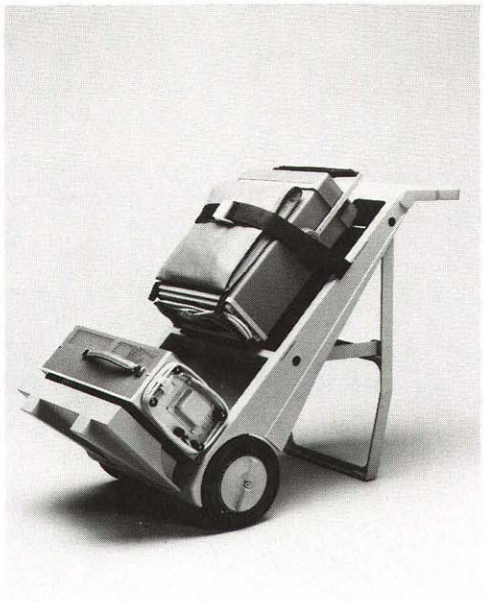
The following film holders are available only through Polaroid (1-800-225-1618 in the U.S.).

**Polaroid #550 Film Holder** — For Polaroid 4 in x 5 in pack films. Holder fits most 4 x 5 cameras and instruments equipped with Graflok backs, which accept conventional 4 in x 5 in film holders.

**Polaroid #405 Film Holder** — For Polaroid 3¼ in x 4¼ in pack films. Holder fits most 4 in x 5 in cameras or instruments equipped with Graflok backs, which accept conventional 4 in x 5 in film holders.

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

NEW



## K117 Instrument Shuttle

### Recommended For:

Transportation of instrumentation, tools, parts kits, and functional accessories in highly mobile environments, such as field service, sales, or support. Once on-site, the five position locking handle can be used as a workstation platform. The instrument shuttle easily travels up stairs, over curbs, and across parking lots.

The **K117** is constructed of high strength structural foam with a textured vapor polish finish. Also included is a tool shelf, locking wheels and two instrument securing belts.

The mainframe accepts a maximum load of 36 kg (80 lb), the handle/workshelf a maximum of 11 kg (25 lb), and the tool shelf a maximum of 18 kg (40 lb). Net weight of the K117 is approximately 8 kg (18 lb). Approximate shipping weight is 13 kg (29 lb).

**ORDERING INFORMATION**

**K117** Instrument Shuttle ..... **$265**

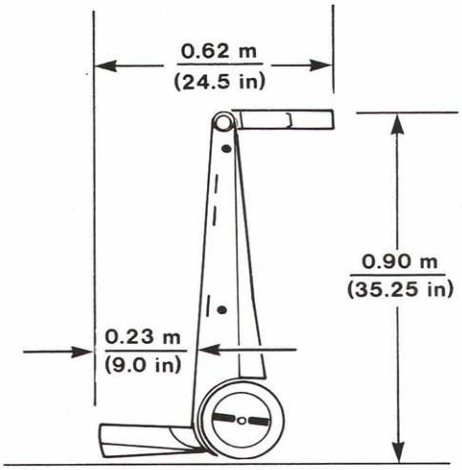
**OPTIONAL ACCESSORIES**

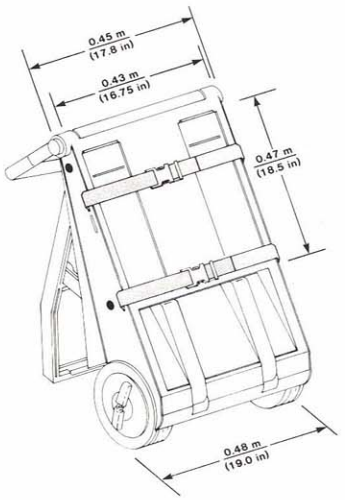
**Rain Cover** — Smoke-grey water-repellant nylon cover with pull cord. Covers and protects the load of a K117. Order 200-3051-00 ..... **$25**

**Pouch** — This black nylon, two-zippered pouch easily carries manuals, probes and small tools. Four snaps secure the pouch to the bale (stand) of the cart for easy access at a work site and out-of-the-way storage in transit. Order 016-0800-00 ..... **$25**

**Securing Belt** — Two inch black webbed nylon belt. Two belts provided with each K117.

**UPRIGHT**



## K212 Portable Instrument

### Recommended For:

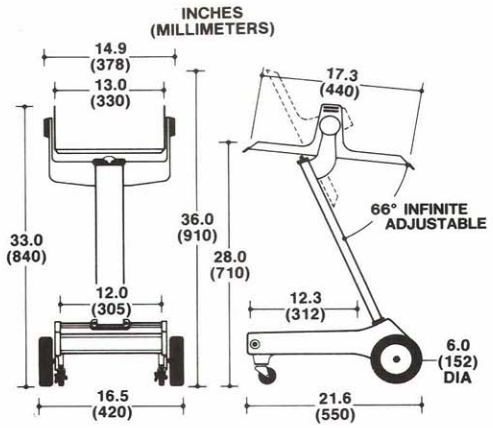
Intrasite transportation of all portable instruments.

The **K212** features a tiltable top tray, locking wheels, and two instrument securing belts. This cart is lightweight, mobile, and easily transports heavy loads.

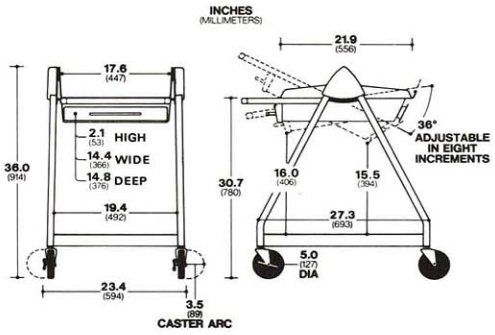
The top tray accepts a maximum load of approximately 36 kg (80 lb). The approximate net weight is 7.3 kg (16 lb) and shipping weight is approximately 12.2 kg (27 lb).

**ORDERING INFORMATION**

**K212** Portable Instrument Cart ..... **$330**




CARTS




## MODEL 205/205D

### Recommended For:

All rackmount width instruments. Note width dimension of top tray in diagram above. Rackmounting ears overhang sides of tray.

**MODEL 205** includes brakes on the front casters, storage drawer, and a power distribution module (three outlets, 4590 mm (15 ft) cord). Maximum top surface weight 36.3 kg (80 lb). Net weight is 19.5 kg (43 lb). Shipping weight is 25.8 kg (57 lb).

**ORDERING INFORMATION**

**Model 205** Blue Vinyl Finish ..... **$490**

**Model 205D** Brown Vinyl Finish ..... **$490**

**OPTIONAL ACCESSORIES**

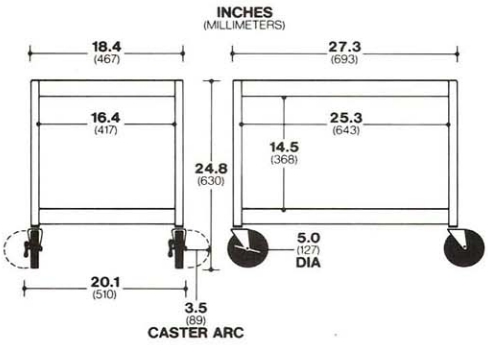
**Safety Belt** — Recommended to secure instruments on top tray. Net weight is 0.23 kg (0.5 lb). Shipping weight is 0.45 kg (1 lb).

**205 Safety Belt** — Order 346-0070-01 ..... **$55**

**205D Safety Belt** — Order 346-0070-03 ..... **$50**

*Model 205*

*Model 206*




## MODEL 206/206D

### Recommended For:

Computer terminals, calculators, and peripherals. General instruments, laboratory and office equipment.

**MODEL 206** includes brakes on the casters at one end of cart. Plastic laminate on top tray and base. Maximum top surface weight is 45.3 kg (100 lb). Net weight is 13.6 kg (30 lb). Shipping weight is 17.2 kg (38 lb).

**ORDERING INFORMATION**

**Model 206** Light Gray Vinyl Finish ..... **$235**

**Model 206D** Brown Vinyl Finish ..... **$235**

## CARTS

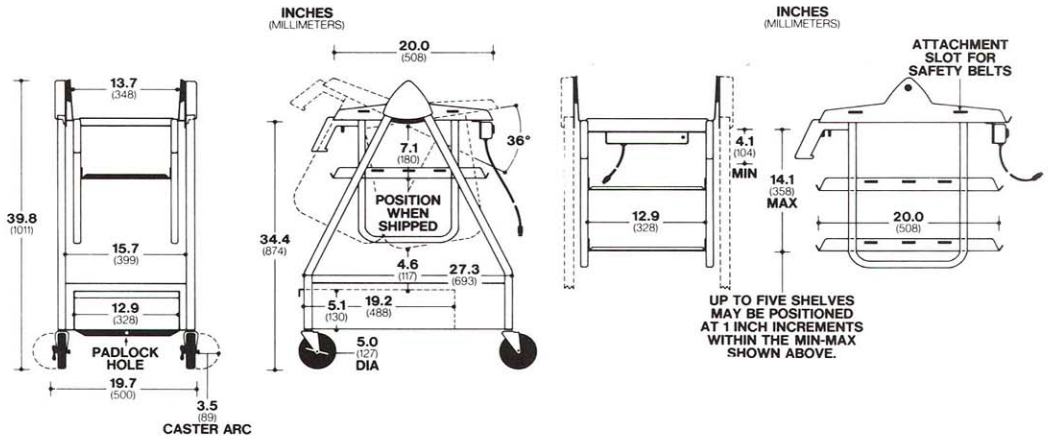
### QUICK REFERENCE

| Product | Cart Model |
|---|---|
| Field Service | ***NEW*** K117 |
| DAS 9100 Series | 205D |
| OF150 | *1 |
| TM 5003 | Model 3 |
| TM 5006 | 205 or 205D |
| TM 503 | Model 3 |
| TM 504 | Model 3 |
| TM 506 | 205 or 205D |
| 1240 Series | ***NEW*** K212 |
| 1420 Series | *1 |
| 2200 Series | ***NEW*** K212 |
| 2400 Series | ***NEW*** K212 |
| 400 Series Portables | ***NEW*** K212 |
| 468 | ***NEW*** K212 |
| 492, 492P, 496, 496P | ***NEW*** K117 or Model 3 |
| 4000 Desktop Series | 206 or 206D |
| 4600 Plotters and Hard Copy System | 206 or 206D |
| 4900 File Managers | 206 or 206D |
| 5000 Series | Model 3 |
| 520A, 521A, 522A | 205 or 205D |
| 528 | *1 |
| 530, 540, 550 Series | Model 3 |
| 560 Series | Model 3 |
| 576 | 206 or 206D |
| 577 | 206 or 206D |
| 600 Series Monitors | *1 |
| 650 Series | 205 or 205D |
| 670 Series | 205 or 205D |
| 7000 Series | Model 3 |

**1 These products are applicable to several carts — see dimensions and features for your specific needs.*

**All prices, quotations, and shipments are FOB Beaverton, OR unless otherwise specified.**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**



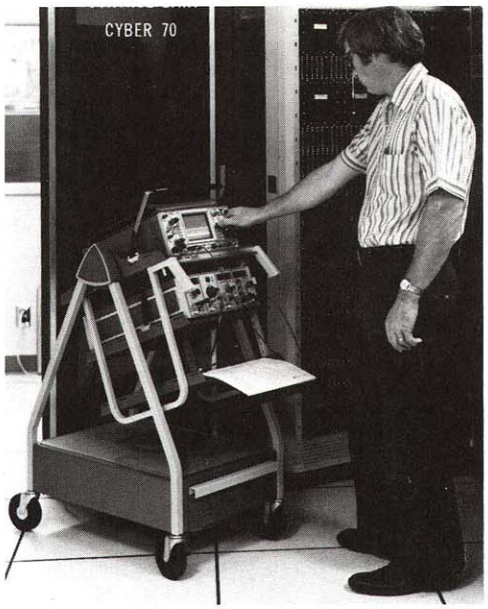

# TEK LAB CART MODEL 3

## Recommended For:

5100, 5400, and 7000 Series three and four plug-in oscilloscopes, TM 503, and TM 504 mounted on top tray.

TM 503, TM 504 mounted on shelves.

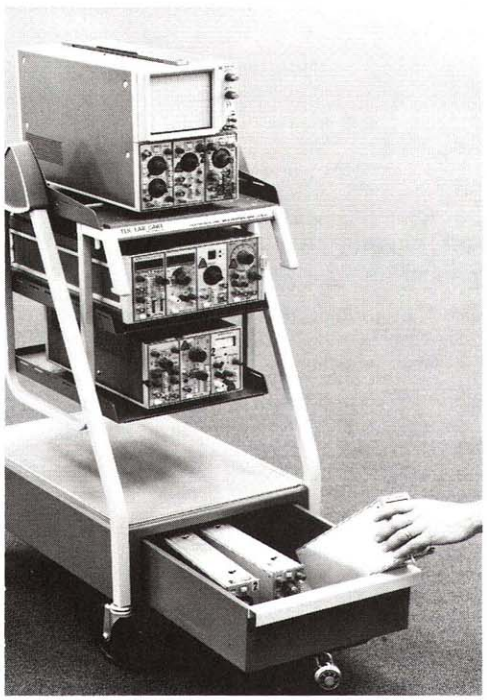
**MODEL 3** includes drawer in base with provision for padlock, brakes on all casters, power distribution module (four outlets and 4590 mm (15 ft) cord, UL listed), removable scope lock-down bar on top tray, one shelf, one safety belt. Accepts a maximum weight of 29.5 kg (65 lbs). Net weight is 25.8 kg (57 lb). Shipping weight is 34 kg (75 lb).




### ORDERING INFORMATION

**Model 3** Blue Vinyl Finish ..... **$595**

**INTERNATIONAL VERSION** deletes power module for shipment outside U.S.A. Order Option 01 ..... **NC**



*The Model 3 is shown with the 436-0132-01 optional shelf, and standard lockable drawer.*

### OPTIONAL ACCESSORIES

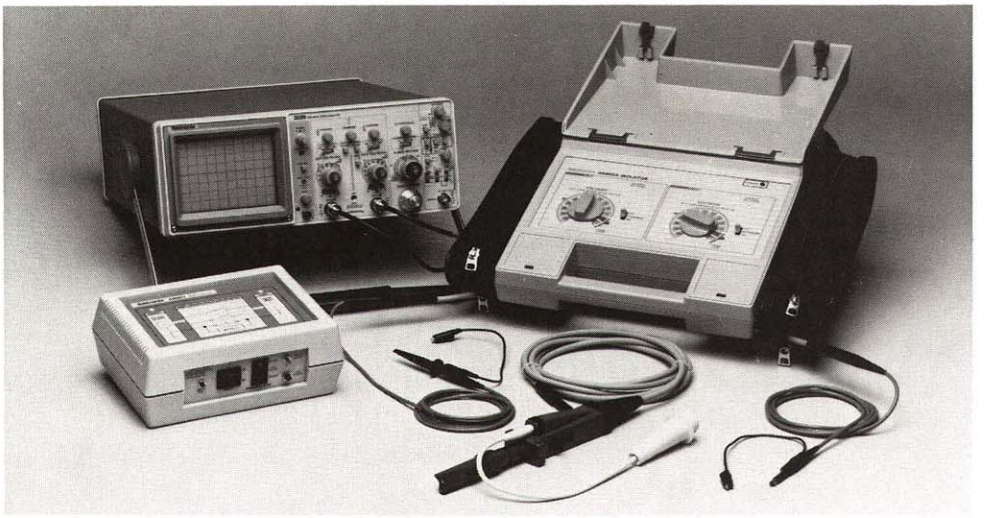
**Model 3 Shelf** — Extra shelf with four mounting screws. Net weight is 0.4 kg (0.9 lb). Shipping weight is 1.4 kg (3 lb). Order 436-0132-01 ..... **$45**

**Safety Belt** — To secure instruments on top tray, shelves, or base 42 inch. (Not needed for 5000 or 7000 Series scopes on top tray.) Net weight is 0.23 kg (0.5 lb). Shipping weight is 0.45 kg (1 lb). Order 346-0136-01 ..... **$25**

For the **7854 keyboard tray** or the **7000/5000 Plug-in storage shelves** contact your local Tektronix Representative.

*Modified Model 3 with 7854 keyboard tray and 7000/5000 Plug-in Storage Shelves.*

**All prices, quotations, and shipments are FOB Beaverton, OR unless otherwise specified.**
**Order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**



## ISOLATION ACCESSORIES FOR FLOATING MEASUREMENTS

In the world of oscilloscope use, the ability to make floating measurements is a pressing need.

This often causes users to employ questionable and often unsafe practices to allow the oscilloscope chassis to float at some potential other than ground. Such practices are parts of a larger problem concerning equipment grounding.

"Floating the scope" is the usual technique that is used in such measurements. It is the technique of defeating the protective grounding system—disconnecting the "signal common" from ground—and allowing accessible oscilloscope parts, such as the chassis, enclosure, connectors, and controls to assume the potential of the point at which the ground lead is connected. This is dangerous for two reasons.

First, and most obvious, is the possibly high voltages on exposed metal parts of the oscilloscope that present a shock hazard to the operator.

Second, and not so obvious, is the cumulative stresses on the oscilloscope power transformer insulation. Such stresses can cause future failure, with attendant shock and fire hazard, even after the oscilloscope is returned to properly grounded operation.

From a measurement standpoint the "floated scope" has the problem of imposing a loading effect on the "signal common". This loading is caused by capacitance between the floating scope chassis and the power line which may be considered at ac ground.

The A6901 and A6902A provide the means to make floating measurements without defeating protective grounding systems, and with minimum risk of operator injury, test equipment damage or signal degradation. Both meet worldwide safety standards; including UL 1244, VDE, CSA Electronics Bulletin 556B, IEC 348 and BS 4743.

## COMMON FLOATING MEASUREMENT TECHNIQUES

Floating measurements are made using various techniques, each having advantages and limitations. Some are unsafe, others distort the waveform measurement. Following are three preferred techniques.

### Differential Techniques

The most popular solution for a floating measurement is the A minus B quasi-differential technique. Most general-purpose dual-trace oscilloscopes (such as the Tektronix 2445) have an Add Mode in which the two channels (invert CH 2) can be electrically subtracted, giving a display of the difference signal. This can be a problem when attempting to examine low-level control signals in the presence of high common-mode voltages. Also, the common-mode dynamic range is severely limited ($\pm 6$ divisions beyond screen height) and CMRR is low—approximately 100:1.

True differential amplifiers are specifically designed to have good rejection of the common-mode signal and display only the difference signal. Because these amplifiers are basically two ground-referenced amplifiers, limited floating or common-mode capability is provided. Further, the ability to display a small signal in the presence of a large common-mode signal changes as a function of the absolute magnitude of the common-mode signal, as well as the ratio of the common-mode signal to the difference signal. Also, there are bandwidth limitations. The Tektronix 7A13 provides 500 volts of common-mode dynamic range at 0.1 V/div with a CMRR of at least 1000:1 and a bandwidth up to 105 MHz.

### Isolation Amplifiers

The isolating amplifier is connected between the signal under investigation and the oscilloscope. With respect to the signal, the amplifier is completely insulated, with no accessible conductive parts. The signal is coupled across an insulating barrier to the oscilloscope. Use of the isolation amplifier maintains the usability of all scope functions.

The Tektronix A6902A Isolator is an isolation amplifier consisting of two identical amplifiers, isolated from each other, from accessible parts, from the mains, and from ground. It enables an oscilloscope to measure potentials from $\pm 20$ mV to $\pm 1500$ volts. Each signal common lead can be independently connected to separate voltages up to plus or minus 1500 volts. The A6902A can measure two such signals simultaneously, in combination with any dual trace oscilloscope.

### Isolator/Differential Amplifier

Using both A6902A channels as a differential input to a 7A13, 7A22, or A plus B invert scope, provides an extra measure of common-mode performance. To use the isolator as a three-wire probe, the common leads are tied together and not connected to the circuit under test. The signal leads are then used as plus and minus differential inputs. This technique provides the isolator's protection and CMRR, as well as the amplifier's CMRR capabilities, and is particularly useful in circuits where the common-to-ground slew rate is high (i.e., above 50 V/$\mu$s).

### Indirect Grounding

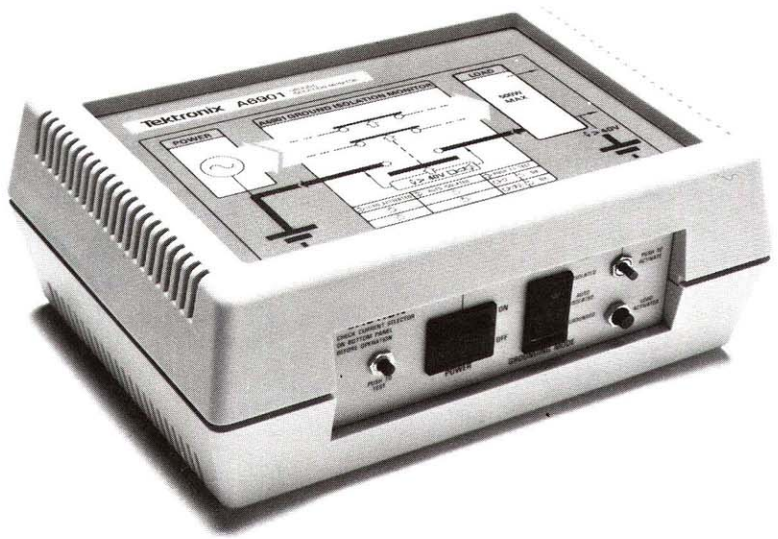
Safety standards specify indirect grounding as an alternative to direct grounding. All of the grounding requirements apply, except that the grounding circuit need not be completed until the available voltage or current exceeds a prescribed amount.

### Ground Isolation Monitor

The Tektronix A6901 Ground Isolation Monitor is an indirect grounding device. It is connected between the mains and the test instrument. When activated, it disconnects the protective grounding system and monitors the voltage and current of the isolated ground. If this voltage exceeds 40 volts peak, the A6901 disconnects the power to the test instrument, sounds an alarm, and reconnects the protective grounding conductor.

The A6901 can be used with any grounded test instrument. It also tests ground continuity of the mains and will not activate if the mains ground is inadequate. It solves the problems of defeating the protective ground and provides the means for valid measurements.

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**




## A6901

**Permits Elevation of Test Instrument Chassis to 40 V Peak (28 V RMS)**

**Aids in Circuit Analysis or Circumventing Ground Loop Noise Problems**

**UL and VDE Safety Certification**

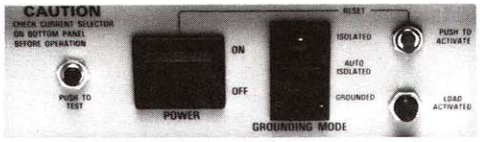
The A6901 is placed between a measurement instrument and its power source and acts as an indirect grounding device, allowing floating measurements to be made with operator protection.

The A6901 monitors the voltage on the isolated system. When the voltage exceeds 40 V peak (28 V RMS) the power source to the instrument is interrupted, the isolated grounding system is connected to the power source grounding system, and an audible alarm is sounded. Before power is supplied to the measurement instrument, the A6901 tests the power source for a functional ground*[1]. If a functional ground is not established, the ground isolation monitor will not go into isolated mode.

Applications for the A6901 include elevating a test instrument chassis to logic reference voltages for more accurate logic level measurements, and isolating a test instrument chassis from common-mode voltages present on ground systems to eliminate undesirable noise from signal measurements.

The A6901 also can be used to test power outlets for proper wiring.

*[1] *If the A6901 is used in conjunction with a GFI (Ground Fault Indicator), consult the GFI manual for compatibility information.*




## CHARACTERISTICS

### ELECTRICAL CHARACTERISTICS

**Trip Voltage (Dc)** — 40 V peak (28 V RMS) or + and − 40 V (within 5%).

**Trip Current** — 0.5 mA, 3.5 mA to 5 mA selectable.

**Neutral-to-Ground Continuity** — Between 3 V and 10 V RMS (8.5 V and 28.3 V p-p), 50 Hz.

**Dc Voltage Trip Delay** — <20 ms.

**Line Voltage Ranges** — 90 V to 128 V RMS, 180 V to 250 V RMS.

**Line Frequency Range** — 48 Hz to 66 Hz.

**Maximum Power Consumption (No External Load)** — 12 W at 115 V, 60 Hz.

**Load Power** — 500 W maximum

### ENVIRONMENTAL CHARACTERISTICS

**Temperature** — Operating: −15°C to +55°C (+5°F to +131°F). Nonoperating: −62°C to +85°C (−80°F to +185°F). Meets MIL-T-28800B, Class 3.

**Altitude** — Operating: To 4600 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft). Exceeds MIL-T-28800B, Class 3.

**Humidity** — Exceeds MIL-T-28800B, Class 3.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Height | 87 | 3.4 |
| Width | 206 | 8.1 |
| Depth | 153 | 6.0 |
| **Weights** | **kg** | **lb** |
| Net (without accessories) | 1.4 | 3.0 |
| Shipping | 2.3 | 5.0 |

### INCLUDED ACCESSORIES

**STANDARD INSTRUMENT, NORTH AMERICAN 120 V**

17.5 cm IEC male to NA female 120 V load cord (161-0150-00); 3 AF DIN metric fuse (159-0190-00); 3 AG 0.062A SLO fuse (159-0051-00); 3 m NA male to IEC female power cord (161-0066-00); instruction manual.

**UNIVERSAL EURO, OPTION A1**

17.5 cm IEC male to Euro female 240 V load cord (161-0157-00); 6.3 A DIN metric fuse (159-0202-00); 0.1 A DIN metric fuse (159-0074-00); 3 m Euro male to IEC female power cord (161-0066-09); instruction manual.

**UNITED KINGDOM OPTION A2**

17.5 cm IEC male to UK female 240 V load cord (161-0159-00); 6.3 A DIN metric fuse (159-0202-00); 0.1 A DIN metric fuse (159-0074-00); 3 m UK male to IEC female power cord (161-0066-10); instruction manual.

**AUSTRALIA, OPTION A3**

17.5 cm IEC male to Australian female 240 V load cord (161-0158-00); 6.3 A DIN metric fuse (159-0202-00); 0.1 A DIN metric fuse (159-0074-00); 3 m Australian male to IEC female power cord (161-0066-11); instruction manual.

**SWITZERLAND, OPTION A5**

17.5 cm IEC male to Swiss female 240 V load cord (161-0160-00); 6.3 A DIN metric fuse (159-0202-00); 0.1 A DIN metric fuse (159-0074-00); 3 m Swiss male to IEC female power cord (161-0154-00); instruction manual.

## ORDERING INFORMATION

**A6901** Ground Isolation Monitor ..... **$450**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A5** — Switzerland 220 V/10 A, 60 Hz
(North American 240 V not available. Neutral not grounded in 240 V North American Systems.)

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## A6902A

**Two Independently Isolated Channels**

**High Voltage/High CMRR**

**UL Certified to 3000 V/Channel (6000 V Maximum Channel Differential)**

**VDE Certified to 1500 V/Channel (3000 V Maximum Channel Differential)**

**Dc to 20 MHz Bandwidth**

A dual-channel, optical- and transformer-coupled voltage isolator, the A6902A allows safely grounded test instruments to make floating measurements at high sensitivity levels in the presence of large common-mode signals.

The A6902A acts as a buffer between the test instrument and the system under test and extends the range of the test instrument to VDE to 1500 V (dc plus peak ac) with the larger industrial probe and to 500 V (dc plus peak ac) with the smaller signal probe. Both probes are quickly interchangeable at the cable connectors. The two pairs of probes and output cables are stored in removable side pouches for availability and convenience.

Designed for use with any dual-channel oscilloscope, the A6902A permits simultaneous observation of two signals at two different points in the same circuit; or signals in two different circuits without respect to common lead voltages.

The two channels can also be combined to function as an input to a differential amplifier.

Separate, calibrated controls for volts per division on each channel provide for precise floating measurements. The all-plastic case and external controls protect the user during control settings and other operations. Other than probe tip connections, the user is never in close proximity to hazardous voltages.

## CHARACTERISTICS

### ELECTRICAL CHARACTERISTICS

**Deflection Factor** — Probe Tip Sensitivity: 20 mV/div to 200 V/div in 1-2-5 sequence with oscilloscope set to 10 mV/div. Accuracy: ≤ ±5% of indicated V/div switch setting.

**Maximum Working Voltage**

**Large Probe (UL is 3000 V, VDE is 1500 V)** — Probe Center Tip to Earth Ground: UL is 3000 V, VDE is 1500 V (dc + peak ac). Probe Center Tip to Probe Common: UL is 3000 V, VDE is 1500 V (dc + peak ac) to 900 kHz. See Figure 1 for voltage derating above 900 kHz. Probe Common to Earth Ground: UL is 3000 V, VDE is 1500 V (dc + peak ac) to 420 kHz. See Figure 2 for voltage derating above 420 kHz.

**Small Probe (500 V)** — Probe Center Tip to Earth Ground: 500 V (dc + peak ac). Probe Center Tip to Probe Common: 500 V (dc + peak ac) to 3 MHz. See Figure 2 for voltage derating above 3 MHz. Probe Common to Earth Ground: 500 V (dc + peak ac) to 6 MHz. See Figure 2 for voltage derating above 6 MHz.

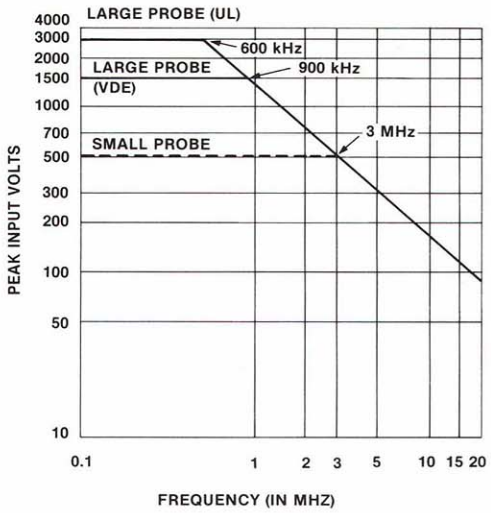



*Figure 1. Maximum working voltage between probe input and probe common (all temperatures).*

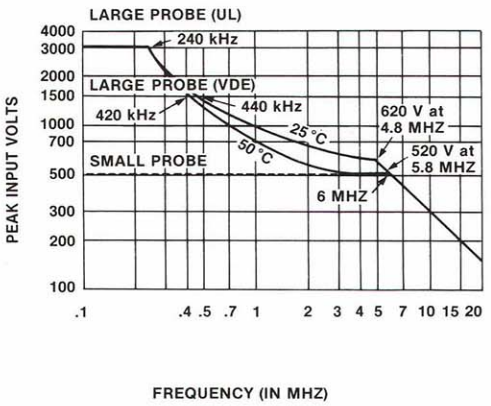



*Figure 2. Maximum working voltage between probe common and earth ground.*

**Frequency Response** — Bandwidth: Dc coupled (to −3 dB points) is ≥20 MHz. Ac coupled (to lower −3 dB point) is ≤5 Hz .

**Transient Response** — Risetime: 17.5 ns (calculated from bw).

**Maximum Input dV/dt** — 100 V/ns.

**Input Impedance** — Resistance: 10 MΩ ±3%. Capacitance: ≈19 pF with either probe.

**Output Impedance** — 50 Ω ±5%.

**Output Drive** — 250 mV p-p typical.

**Common-Mode Capacitance** — 200 pF from probe common to earth ground.

**Maximum Common to Ground Slew Rate** — 50 V/μs.

**Tangential Noise** — 2.0 mV. Dc Drift With Temperature: ≤1 mV/°C (0.1 div/°C) at output. Range of Output Dc Level: At least +5 div from center screen.

**Channel Isolation** — Maximum Voltage: Using two 1500 V probes is 3000 V (dc + peak ac). Using two 500 V probes is 1000 V (dc + peak ac).

**Delay** — 42 ns ±3 ns from probe input to instrument input. CH1, CH2 delay difference is ≤4 ns.

**Common Lead Signal Feedthrough** — −106 dB from probe input to output BNC to 500 Hz. See Figure 3 for derating above 500 Hz.

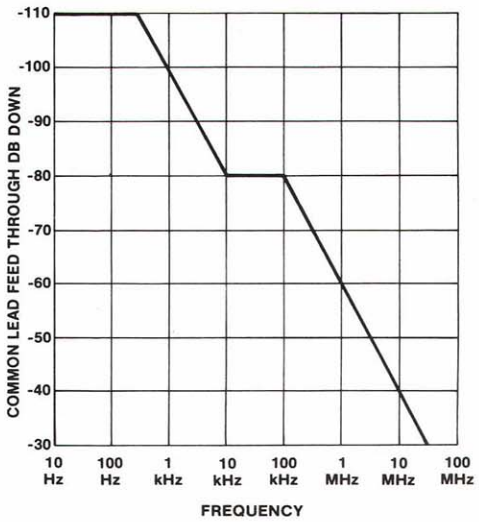



*Figure 3. Common-lead feedthrough characteristics.*

### POWER SOURCE CHARACTERISTICS

**Line Voltage Ranges** — Low: 90 V to 132 V. High: 180 V to 250 V.

**Line Frequency Range** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 17 W at 115 V, 60 Hz.

### ENVIRONMENTAL CHARACTERISICS

**Temperature** — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Altitude** — Operating: To 4600 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft).

**Humidity (Operating and Nonoperating)** — Five cycles (120 hr total) with equipment tested nonoperating to MIL-STD-810C Method 507.1, at 90% to 95% relative humidity and 30°C to 60°C.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Height | 136 | 5.4 |
| Width | 394 | 15.5 |
| Depth | 344 | 13.5 |
| **Weight** | **kg** | **lb** |
| Net w/Accessories | 6.2 | 13.7 |
| Shipping | 8.0 | 17.7 |

### INCLUDED ACCESSORIES

Two 3000 V (VDE is 1500 V) isolation probes (010-0409-01); two 500 V isolation probes (010-0411-10); 0.15 ASB 250 V fuse (159-0054-00); 0.1 ASB 250 V fuse (159-0048-00—Europe); right angle power cord (161-0117-00); two 2 m, 50 Ω output cables (012-0204-00); operator's manual, service manual.

## ORDERING INFORMATION

**A6902A** Isolator ..... **$1,985**

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## THE STRONGEST LINK BETWEEN YOUR TEK INSTRUMENT AND RESULTS.

Tek instruments are designed for users who place a premium on equipment quality and on reliability of results. Tek probes are engineered, assembled and tested to provide the most compatible link possible between those instruments and the outside world.

**PROBES: SELECTION CRITERIA**

**No factor is more critical to optimized system performance than proper probe selection.** A probe that's not right for your application can mean a significant loss in measurement results, plus costly delays and errors.

**For over 35 years, Tektronix has been designing probes that are matched not only to our scopes, but to your own instrument and application needs.** They minimize circuit loading, while extending and enhancing system performance.

By extending our resistive-wire, center-conductor cable technology, Tek 10X Passive probes can transfer a signal frequency that exceeds 300 MHz and presents only an added 3 pF per meter of cable to a circuit.

Tek probe products include active voltage probes, active and passive current probes, high voltage probes, low impedance/high frequency probes, and differential probes.

Bandwidth/risetime, input voltage, input impedance and limiting aberrations are all characteristics to evaluate in terms of your own application.

While electrical considerations are of major importance in your selection, physical parameters, such as probe length and proper tip adaptor, can be equally crucial. Unnecessary cable length, for example, will decrease bandwidth and increase the loading capacitance of the probe.

You'll find a wide variety of adaptors and probe tips available which feature Tek's special alloy coating that minimizes low current conduction problems. All are inherent to the Tek modular probe concept that lets you snap tips and other probe parts together without tools, so maintenance and repair of damaged probes is of minimal expense.

## PROBE TYPES

### Current Probes

Current probes provide a method to measure the current flowing in a circuit. For instance, their use can eliminate the calculations that would be required to determine the current from the voltage drop across a current sampling resistor.

Two types of current probes are available, the traditional ac only probe and the "Hall effect" type. Ac only current probes use a transformer to convert current flux into ac signals and have a frequency response from a few hundred hertz to 100 MHz. Hall effect current probes include semiconductors to provide a frequency response from dc to 50 MHz.

A current probe is used by clipping its jaws around the wire that is carrying the current to be measured. Because it is "noninvasive", a current probe imposes less loading than other probes (typically less than a few nanohenrys in series with the wire at a capacitance of less than 1 pF). Differential current measurements are made by passing the two wires (in correct phase) through the current probe jaws.

The CT-5 increases the high-current measuring capability of most current probes by either 20:1 or 1000:1.

### Differential Probes

The normal 10X probe has a typical accuracy of ±1%, giving a scope/probe common-mode rejection ratio of no more than 50:1. Using a matched pair of P6055 differential probes, common-mode rejection ratios of 20,000:1 or better can be obtained.

### Active Probes

Active components contained in these probes result in high input resistance and low input capacitance without loss of signal. Dynamic range and measurement capability are substantially increased through the voltage offset control.

Since active probes have a selectable 50 Ω output impedance, the distance from the probe tip to the instrument is only limited by the bandwidth limit of the 50 Ω coaxial cable between the probe and instrument.

### 50 Ω Probes

Probes provide the lowest input capacitance (typically 1 pF for high frequency signals) and are used with high frequency, 50 Ω input scopes. The probes provide the most consistent probe loading because they exhibit a frequency response that is essentially flat.

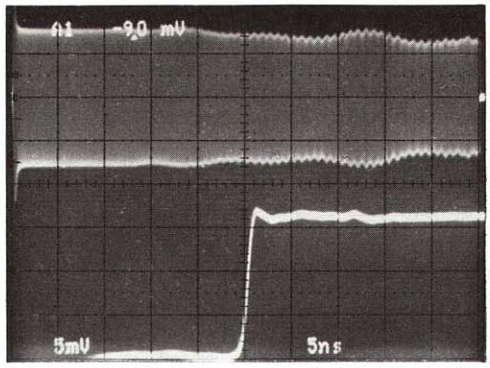
### High Voltage Probes

Several high voltage probes are available from Tektronix that provide 100X or 1000X compensated dividers. Because these probes are primarily designed for high voltage applications, input capacitance is reduced to approximately 3 pF by the high division ratio.

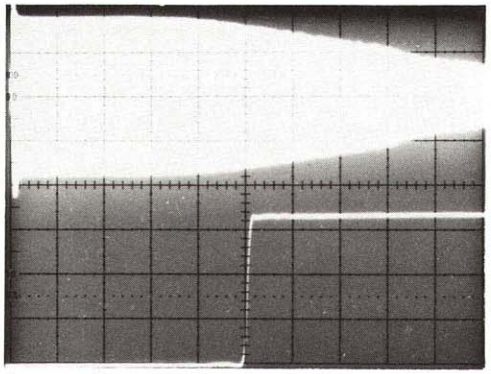
### Why Tek Probes—See the Difference

The pictures to the right show signals measured with Tek probes and their commodity counterparts. To get the best performance from your measurement system use Tek probes!

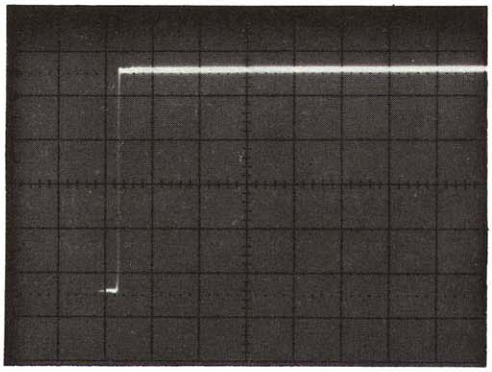
**Optimum Performance With Tek**



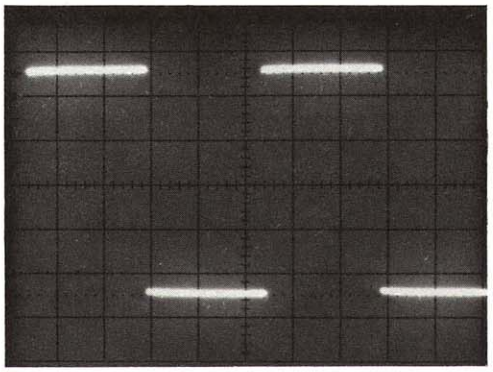

*Bandwidth: Tek probe faithfully transmits 300 MHz signal.*



*Frequency Response: Tek probes evenly matched for clear response.*

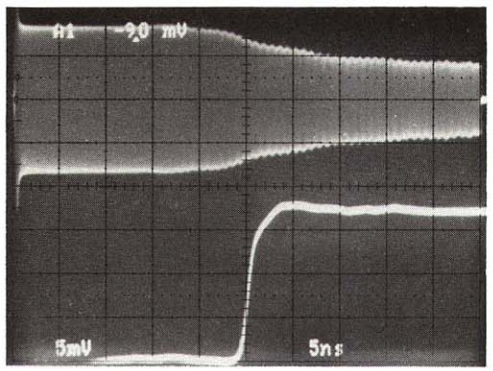


*Probe Tip Accessories: By choosing the appropriate ground lead from Tek probe accessories, ringing does not exist.*

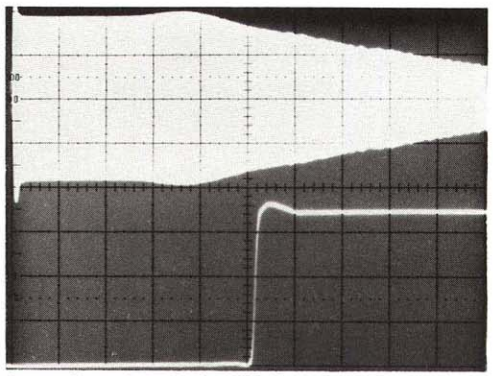


*Environmental: Tek offers superior performance. No signal degradation after five days in high humidity.*

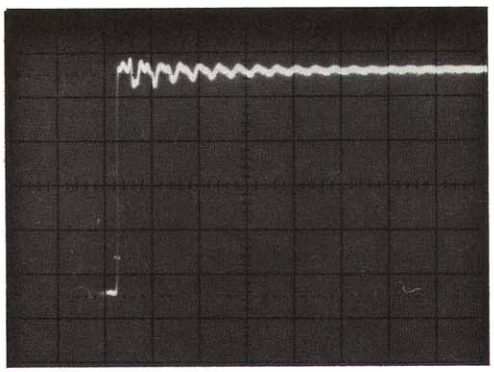
**Loss With Commodity Probe**



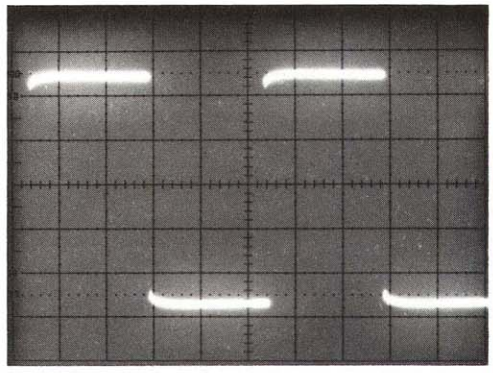

*Commodity probe limits same signal to 200 MHz.*



*Commodity probe peaked resulting in aberrations.*



*Commodity probes may not have the right selection of accessories to make a faithful measurement.*



*Commodity probe shows "hook" after same humidity test.*

## ACTIVE PROBES

Active probes have high input resistance and low input capacitance through their dynamic range.

Used in measurements where high input resistance and low input capacitance is needed and where frequencies above 250 MHz are encountered.

| Type | Attn | Nominal Length | Package Number | Loading | | Risetime | Input Limits: Maximum Dc + Pk Ac | Input Limits: Linear Dynamic Range | Input Limits: Dc Offset Range | Read-Out | Page |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **P6046 Diff/Amp** | 1X<br>10X | 6 ft | 010-0232-00 Std<br>Inc PS & Amp | 1 MΩ<br>10 MΩ | 10 pF<br>3 pF | 3.5 ns | ±25 V<br>±250 V | ±5 V<br>±50 V | | NO | 443 |
| **P6201 FET** | 1X<br>10X<br>100X | 6 ft | 010-6201-01 | 100 kΩ<br>1 MΩ<br>1 MΩ | 3 pF<br>1.5 pF<br>1.5 pF | 0.4 ns | ±100 V<br>±200 V<br>±200 V | ±0.6 V<br>±6 V<br>±60 V | ±5.6 V<br>±56 V<br>±200 V | YES | 442 |
| **P6202A FET** | 10X<br>100X | 2 m | 010-6202-03 Std<br>w/010-0384-00 Atn | 10 MΩ<br>10 MΩ | 2 pF<br>2 pF | 0.7 ns<br>0.7 ns | ±200 V<br>±200 V | ±6 V<br>±60 V | ±55 V<br>±200 V | YES<br>NO | 442 |
| **P6230 Bias/ Offset** | 10X | 1.5 m | 010-6230-01 | 450 Ω | 1.3 pF | 230 ps | ±30 V | ±5 V | ±5 V | YES | 441 |

## 50 Ω DIVIDER PROBES

For use with 50 Ω systems. For risetime measurements, the interaction of the probe capacitance with the source impedance is important (RC time constant). For best results, the capacitance should be kept minimal. Typical probe specifications represent their response to a 25 Ω source environment.

| Type | Attn | Nominal Length | Package Number | Loading | | Risetime | Input Limits: Maximum Dc + pk Ac | Input Limits: Linear Dynamic Range | Read-Out | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| **P6056** | 10X | 6 ft<br>9 ft | 010-6056-03 Std<br>010-6056-05 | 500 Ω | 1 pF | 0.1 ns | ±16 V | ±16 V | YES | 443 |
| **P6057** | 100X | 6 ft<br>9 ft | 010-6057-03 Std<br>010-6057-05 | 5 kΩ | 1 pF | 0.25 ns | ±50 V | ±50 V | YES | 443 |

## CURRENT PROBES

Used to measure currents from dc to 1000 A.

Current probes can be used where low loading of the circuit is necessary. Loading is typically in the mΩ to low Ω range. Current probes can be used for differential measurements; where the probe measures the results of two opposing currents in two conductors in the jaw of the probe.

A current waveform may be very different from a voltage waveform in a current-dependent circuit. Measuring only the voltage will not show this difference. A measurement of the current waveform is necessary to obtain the total picture.

| Type | Bandwidth Hz to MHz | Displayed Current/Div | Maximum Current: Peak Pulse | Maximum Current: Dc + pk Ac | Maximum Current: Ac P-P | Maximum Current: Derate Below | Maximum Current: Derate Above | Saturation: Dc | Saturation: Amp-S Product | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| **A6302/ AM 503** | Dc 50 | 1 mA to 5 A*1 | 50 A | 20 A | 40 A | | 20 kHz | 20 A | 100 x $10^{-6}$ | 446 |
| with CT-5 | 0.5 20 | 20 mA to 5 kA*1 | 50 kA | | 40 kA | 20 Hz | 1.2 kHz | | 0.1 | 448 |
| **A6303/ AM 503** | Dc 15 | 10 mA to 50 A*1 | 500 A | 100 A | 200 A | | 20 kHz | 100 A | 10,000 x $10^{-6}$ | 446 |
| **P6021** w/Passive Term. | 120 60 | 20 mA or 100 mA*1 | 250 A | | 15 A | 300 Hz | 5 MHz | 0.5 A | 500 x $10^{-6}$ | 447 |
| + CT-5 | 120 20 | 400 A or 100 kA*1 | 50 kA | | 2000 A | 300 Hz | 1.2 kHz | 20 A | 0.5 | 448 |
| with 134 | 12 38 | 1 mA to 1 A*2 | 250 A | | 15 A | 230 Hz | 5 MHz | 0.5 A | 500 x $10^{-6}$ | 447 |
| + CT-5 | 12 20 | 20 mA to 1 kA*2 | 15 kA | | 2000 A | 230 Hz | 1.2 kHz | 20 A | 0.5 | 448 |
| **P6022** w/Passive Term. | 935 120 | 10 mA or 100 mA*1 | 100 A | | 6 A | 3 kHz | 10 MHz | 0.2 A | 9 x $10^{-6}$ | 447 |
| with 134 | 100 65 | 1 mA to 1 A*2 | 100 A | | 6 A | 1.3 kHz | 10 MHz | 0.2 A | 9 x $10^{-6}$ | 447 |
| **CT-1** | 25 k 1000 | 0.5 mA*1 (5 mV/mA) | 12 A | | 1.4 A | | | 0.2 A | 1 x $10^{-6}$ | 448 |
| **CT-2** | 1.2 k 200 | 0.1 mA*1 (1 mV/mA) | 36 A | | 7 A | | | 0.2 A | 50 x $10^{-6}$ | 448 |

*1 Scope set at 10 mV/div.
*2 Scope set at 50 mV/div.

## OTHER PROBES

Recommended Probes—For 7000 Series see page 227, for 5000 Series see page 273, for others see the individual instrument description.

| Probe | Package Number | Function | Use | Page |
|---|---|---|---|---|
| **P6048** | 010-0215-00 | Low Capacitance 1 pF, 1 kΩ | 400 Series | 443 |
| **P6058A** | 010-6058-01 | Temperature and Voltage Probe | DM 501, 7D13 | — |
| **P6430** | 010-6430-00 | Temperature Probe | DM 44, DM 502 | — |
| **P6104** | 010-6104-00 | Voltage Probe | 465M | — |
| **40 kV** | 010-0277-00 | High Voltage Dc Probe | 2337, DM 501A, DM 502A | 380 |
| **P6451** | 010-6451-03 | Data Acquisition Probe | 7D01 | 129 |
| **P6401** | 010-6401-01 | Logic Probe | TTL Logic | 129, 444 |
| **P6406** | 010-6406-01 | Word Recognizer | 308 | 129 |
| **P6420** | 010-6420-03 | RF Probe for DMM's | 2337, DM 501A, DM 502A, DM 44 | 445 |
| **P6601** | 010-6601-01 | Temperature Probe | DM 501A, DM 502A, 7D13A | 380 |
| **P6602** | 010-6602-00 | Temperature Probe | 2236 DMM | 444 |
| **P6125** | 010-6125-01 | Digital Counter/Timer Probe, 5X Attenuation | DC 503A, DC 504, DC 505A, DC 508, DC 509 | 373 |

## PASSIVE PROBES

For amplitude measurements, the capacitance and resistance of the probe form a voltage divider with the circuit under test. For low frequency (about 5 MHz and below), the resistive component is of primary importance in most probes and should be at least two orders of magnitude greater than the circuit source impedance. For frequencies higher than 30 MHz), the importance of the capacitance increases drastically and will become the prime consideration.

For general-purpose use, passive voltage probes offer a wide probe selection for a variety of applications for 1 MΩ inputs.

Modular probes are an exciting new concept in probe design. The P6101A, P6105A, P6106A, P6107A, P6108A, P6121, P6122, P6130, P6131 and P6149A probes divide into three modules (probe heads, cables, and connector/compensation boxes.)

### VOLTAGE PROBES FOR 1 MΩ INPUTS

#### MODULAR

| TYPE | ATTEN | LENGTH (m)*1 | PACKAGE NUMBER | LOADING | | BW MHz*2*4 at −3 dB | DC MAXIMUM | SCOPE C IN pF | READOUT | PAGE |
|---|---|---|---|---|---|---|---|---|---|---|
| P6101A | 1X | 1.0<br>2.0<br>3.0 | 010-6101-11<br>010-6101-13<br>010-6101-15 | 1 MΩ | 32.0 pF<br>54.0 pF<br>78.0 pF | 34.0<br>15.5<br>8.0 | 500 V | ANY | — | 450 |
| P6105A | 10X | 1.0<br>2.0<br>3.0 | 010-6105-11<br>010-6105-13<br>010-6105-15 | 10 MΩ | 8.7 pF<br>11.2 pF<br>13.2 pF | 100.0<br>100.0<br>90.0 | 500 V | 15 to 35<br>15 to 35<br>15 to 30 | YES | 450 |
| P6106A | 10X | 1.0<br>2.0<br>3.0 | 010-6106-11<br>010-6106-13<br>010-6106-15 | 10 MΩ | 8.7 pF<br>11.2 pF<br>13.2 pF | 250.0<br>250.0<br>150.0 | 500 V | 15 to 35<br>15 to 35<br>15 to 30 | YES | 450 |
| P6107A | 10X | 2.0 | 010-6107-13 | 10 MΩ | 13.0 pF | 100.0 | 500 V | 20 to 51 | YES | 450 |
| P6108A | 10X | 1.0<br>2.0<br>3.0 | 010-6108-11<br>010-6108-13<br>010-6108-15 | 10 MΩ | 8.7 pF<br>11.2 pF<br>13.2 pF | 100.0<br>100.0<br>90.0 | 500 V | 15 to 35<br>15 to 35<br>15 to 30 | NO | 450 |
| P6121 | 10X | 1.5 | 010-6121-01 | 10 MΩ | 11.0 pF | 100.0 | 500 V | 20 to 26 | YES | 451 |
| P6122 | 10X | 1.5<br>2.0<br>3.0 | 010-6122-01<br>010-6122-03<br>010-6122-05 | 10 MΩ | 11.0 pF<br>12.0 pF<br>14.0 pF | 100.0<br>100.0<br>90.0 | 500 V | 15 to 35 | NO | 451 |
| P6125 | 5X | 1.5 | 010-6125-01 | 5 MΩ | 20.0 pF | 200.0 | 250 V | 15 to 33 | NO | 373 |
| P6130 | 10X | 1.5<br>2.0<br>3.0 | 010-6130-01<br>010-6130-03<br>010-6130-05 | 10 MΩ | 12.7 pF<br>13.2 pF<br>14.5 pF | 250.0<br>250.0<br>150.0 | 500 V | 15 to 35<br>15 to 35<br>15 to 30 | YES | 452 |
| P6131 | 10X | 1.3<br>2.0<br>3.0 | 010-6131-01<br>010-6131-03<br>010-6131-05 | 10 MΩ | 10.8 pF<br>13.5 pF<br>14.5 pF | 300.0<br>250.0<br>150.0 | 500 V | 14 to 18 | YES | 452 |
| P6149A | 10X | 2.0 | 010-6149-13 | 10 MΩ | 15.5 pF | 50.0 | 500 V | 20 to 51 | NO | 450 |

#### MONOLITHIC

| TYPE | ATTEN | LENGTH (ft)*1 | PACKAGE NUMBER | LOADING | | BW MHz*2*4 at −3 dB | DC MAXIMUM | SCOPE C IN pF | READOUT | PAGE |
|---|---|---|---|---|---|---|---|---|---|---|
| P6006 | 10X | 3.5<br>6<br>9<br>12 | 010-0127-00<br>010-0160-00<br>010-0146-00<br>010-0148-00 | 10 MΩ | 7.5 pF*2<br>8.5 pF<br>11.0 pF<br>15.0 pF | 35.0<br>25.0<br>25.0<br>12.0 | 600 V | 15 to 55 | NO | — |
| P6007 | 100X | 3.5<br>6<br>9<br>12 | 010-0150-00<br>010-0165-00<br>010-0152-00<br>010-0154-00 | 10 MΩ | 2.0 pF*2<br>2.2 pF<br>2.4 pF<br>2.6 pF | 25.0<br>20.0<br>15.0<br>13.0 | 1.5 kV | 15 to 55 | NO | 453 |
| P6008 | 10X | 3.5 | 010-0129-00 | 10 MΩ | 7.5 pF | 100.0 | 600 V | 12 to 47 | NO | — |
| P6008 (Environmentalized) | 10X | 6 | 010-0129-01 | 10 MΩ Environmentalized −50°C to +150°C | 7.5 pF | 100.0 | 600 V | 12 to 47 | NO | 445 |
| P6009 | 100X | 9<br>9 | 010-0170-00<br>010-0264-01 | 10 MΩ | 2.5 pF<br>2.5 pF | 120.0<br>100.0 | 1.5 kV | 12 to 47 | NO<br>YES | 453 |
| P6010 | 10X | 3.5 | Furnished with S-5. For other uses see P6105 or P6106. | | | | | | | |
| P6015 | 1000X | 10 | 010-0172-00 | 100 MΩ | 3.0 pF | 75.0 | 20 kV | 12 to 47 | NO | 453 |
| P6028 | 1X | 3.5<br>6<br>9<br>12 | 010-0074-00<br>010-0075-00<br>010-0076-00<br>010-0077-00 | 1 MΩ | 50.0 pF<br>67.0 pF<br>90.0 pF<br>112.0 pF | 17.0<br>10.0<br>7.0<br>4.0 | 600 V | ANY | YES | — |
| P6048 | 10X | 6 | 010-0215-00 | 1 kΩ | 1.0 pF | 100.0 | 20 V | 15 to 20 | NO | 443 |
| P6053B | 10X | 3.5<br>6<br>9 | 010-6053-11<br>010-6053-13<br>010-6053-15 | 10 MΩ | 9.5 pF<br>12.5 pF<br>13.5 pF | 200.0<br>200.0<br>115.0 | 500 V | 15 to 24 | YES*5 | 454 |
| P6055*3 | 10X | 3.5 | 010-6055-01 | 1 MΩ | 10.0 pF | 60.0 | 500 V | 20 to 47 | YES | 454 |
| P6060 | 10X | 3.5<br>6 | 010-6060-01<br>010-6060-03 | 1 MΩ | 7.5 pF*2<br>8.5 pF | 35.0<br>25.0 | 500 V | 15 to 55 | YES | — |
| P6062B | 10X or 1X<br>10X or 1X<br>10X or 1X | 3.5<br>6<br>9 | 010-6062-11<br>010-6062-13<br>010-6062-15 | 10 MΩ<br>1 MΩ<br>10 MΩ<br>1 MΩ<br>10 MΩ<br>1 MΩ | 13.5 pF<br>100.0 pF<br>14.0 pF<br>105.0 pF<br>17.0 pF<br>135.0 pF | 100.0<br>8.0<br>100.0<br>6.0<br>95.0<br>4.5 | 500 V | 15 to 47 | YES | 454 |
| P6063B | 10X or 1X<br>10X or 1X | 3.5<br>6 | 010-6063-11<br>010-6063-13 | 10 MΩ<br>1 MΩ<br>10 MΩ<br>1 MΩ | 11.0 pF<br>80.0 pF<br>14.0 pF<br>105.0 pF | 200.0<br>12.0<br>200.0<br>6.0 | 500 V | 15 to 24 | YES | 454 |

*1 *All lengths are nominal and measured electrically for optimum performance.*

*2 *Rating varies with scopes having other than 20 pF inputs.*

*3 *Designed for use with scopes having differential inputs.*

*4 *25 Ω source.*

*5 *Trace identification button.*

## PROBE/INSTRUMENT COMPATIBILITY

For quick reference only to suggest some of the possible probe/instrument combinations. Check probe descriptions on the following pages for more information or call your Tektronix Sales Representative or the Tek National Marketing Center for assistance.

### 7000 Series

| | PASSIVE | ACTIVE | CURRENT |
|---|---|---|---|
| 7A11 | Built in FET Probe | | A6302/AM 503<br>A6303/AM 503 |
| 7A13 | P6055 P6015<br>P6101A P6009<br>P6062B P6105A<br>P6122 | | P6021<br>P6022 |
| 7A15A | P6101A P6015<br>P6105A P6009<br>P6062B P6122<br>P6130 | | P6021<br>P6022 |
| 7A16A | P6106A P6015<br>P6101A P6009<br>P6063B P6130<br>P6053B | P6201<br>P6202A<br>P6230 | P6021<br>P6022<br>A6302/AM 503 |
| 7A18A | P6101A P6015<br>P6105A P6009<br>P6062B P6122<br>P6130 | P6202A | P6021<br>A6302/AM 503 |
| 7A19 | P6056<br>P6057 | P6201<br>P6202A<br>P6230 | A6302/AM 503<br>A6303/AM 503 |
| 7A22 | P6101A P6055<br>P6062B | | P6021<br>A6302/AM 503 |
| 7A24 | P6056<br>P6057 | P6201<br>P6202A<br>P6230 | A6302/AM 503<br>A6303/AM 503 |
| 7A26 | P6063B P6015<br>P6048 P6009<br>P6053 P6130 | P6201<br>P6202A<br>P6230 | P6022<br>A6302/AM 503<br>A6303/AM 503 |
| 7A29 | P6056<br>P6057 | P6201<br>P6202A<br>P6230 | A6302/AM 503<br>A6303/AM 503 |
| 7A42 | P6131 | P6230 | |
| 7D12 | P6055 | | |
| 7D13A | P6601 P6420<br>40 kV(010-0277-00) | | |
| 7D20 | P6053B | | |

### 5000 Series

| | PASSIVE | ACTIVE | CURRENT |
|---|---|---|---|
| 5A14N<br>5A15N<br>5A18N | P6101A P6015<br>P6108A P6007<br>P6062B | | P6021<br>A6302/AM 503 |
| 5A21N<br>5A26 | P6101A P6055<br>P6062B | | P6021 |
| 5A22N | P6101A P6055<br>P6062B | | |
| 5A38<br>5A45<br>5A48 | P6101A P6015<br>P6105A P6009<br>P6062B P6122 | | P6021<br>P6022<br>A6302/AM 503 |
| 5D10 | P6101A P6105A<br>P6007 P6015<br>P6062B | | P6021 |

### 2400 Series

| | PASSIVE | ACTIVE | CURRENT |
|---|---|---|---|
| 2445<br>2465 | P6131 P6015<br>P6101A P6009 | P6201<br>P6202A<br>P6230 | A6302/AM 503<br>A6303/AM 503 |

**1 For T935A and T932A only*
**2 For T922R, T921 and T912 only*

### 2300 Series

| | PASSIVE | ACTIVE | CURRENT |
|---|---|---|---|
| 2335<br>2336 | P6101A P6108A<br>P6009 P6015<br>P6063B P6130 | P6202A | P6021<br>P6022 |
| 2337 | P6101A P6108A<br>P6009 P6015<br>P6063B P6130<br>P6420<br>40 kV(010-0277-00) | P6202A | P6021<br>P6022 |

### 2200 Series

| | PASSIVE | ACTIVE | CURRENT |
|---|---|---|---|
| 2213A<br>2215A | P6122 P6101A<br>P6015 P6009 | P6202A*1 | P6021,P6022<br>A6302/AM 503<br>A6303/AM 503 |
| 2235<br>223501 | P6122 P6015<br>P6101A P6009 | P6202A*1 | P6021, P6022<br>A6302/AM 503<br>A6303/AM503 |
| 2236 | P6121 P6015<br>P6101A P6009<br>P6602 | P6202A*1 | P6021, P6022<br>A6302/AM 503<br>P6303/AM 503 |

**1 Requires 1101A Power Supply.*

### 400 Series

| | PASSIVE | ACTIVE | CURRENT |
|---|---|---|---|
| 485 | P6101A P6015<br>P6106A P6009<br>P6056 P6048<br>P6057 P6130<br>P6063B | P6201<br>P6202A<br>P6230 | P6021<br>P6022<br>A6302/AM 503<br>A6303/AM 503 |
| 475A<br>475 | P6101A P6015<br>P6106A P6009<br>P6063B P6048<br>P6130 | P6201<br>P6202A<br>P6230 | P6021<br>P6022<br>A6302/AM 503<br>A6303/AM 503 |
| 465B<br>465<br>468 | P6101A P6015<br>P6105A P6009<br>P6062B P6048<br>P6130 | P6201<br>P6202A | P6021<br>P6022<br>A6302/AM 503<br>A6303/AM 503 |
| 465M | P6101A P6015<br>P6104A P6009<br>P6130 | P6201<br>P6202A | P6021<br>P6022<br>A6302/AM 503<br>A6303/AM 503 |
| 466<br>464 | P6101A P6015<br>P6105A P6009<br>P6062B P6130 | P6201<br>P6202A<br>P6230 | P6021<br>P6022<br>A6302/AM 503<br>A6303/AM 503 |
| 455 | P6101A P6015<br>P6105A P6009<br>P6062B | P6202A | P6021<br>P6022<br>A6302/AM 503<br>A6303/AM 503 |
| 434 | P6101A<br>P6108A P6105A<br>P6009<br>P6015 | | P6021<br>P6022<br>A6302/AM 503<br>A6303/AM 503 |

### 300 Series

| | PASSIVE | ACTIVE | CURRENT |
|---|---|---|---|
| 308 | P6107A | P6404<br>P6451 | |
| 305, 314,<br>323, 326,<br>335, 336 | P6101A<br>P6149A | | P6021, P6022<br>A6302/AM 503<br>A6303/AM 503 |
| 390AD | P6101A P6105A<br>P6062B P6015<br>P6122 | | P6021<br>P6022 |

### T900 Series

| | PASSIVE | ACTIVE | CURRENT |
|---|---|---|---|
| T935A<br>T932A<br>T922R<br>T921<br>T912 | P6101A P6122<br>P6108A P6062B<br>P6009*1 P6007*2<br>P6015 P6006 | | P6021<br>A6302/AM 503<br>A6303/AM 503 |

**1 For T935A and T932A only.*
**2 For T922R, T921 and T912 only.*

### TM 5000 Series

| | PASSIVE | ACTIVE | CURRENT |
|---|---|---|---|
| DC 5009 | P6125 P6122 | | |
| DC 5010 | P6125 P6056<br>P6130 | P6201<br>P6202A<br>P6230 | |
| SI 5010 | P6056 P6057 | P6201<br>P6202A<br>P6230 | A6302/AM 503 |

### TM 500 Series

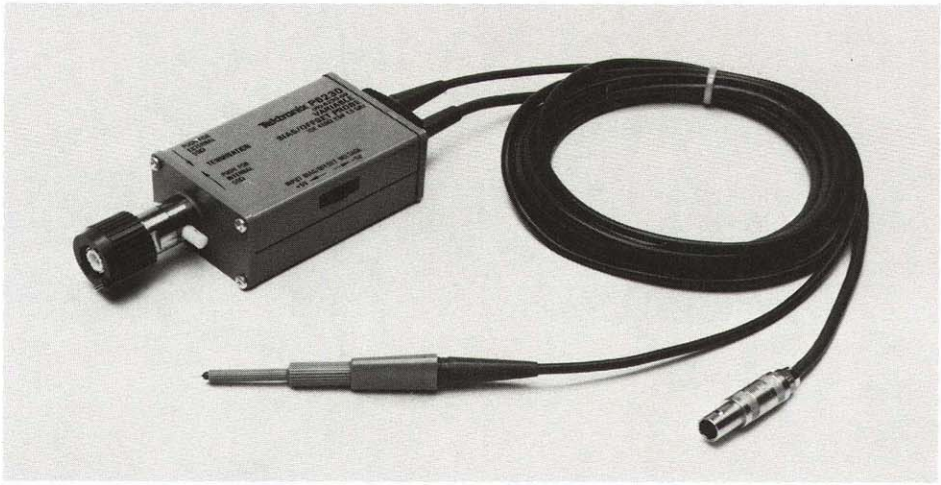
| | PASSIVE | ACTIVE | CURRENT |
|---|---|---|---|
| AM 502 | P6055 P6101A | | P6021 |
| AM 503 | | | A6302<br>A6303 |
| DM 501A<br>DM 502A<br>DM 505 | P6420<br>40 kV(010-0277-00)<br>P6601 | | |
| DC 503A<br>DC 504<br>DC 505A<br>DC 509 | P6125<br>P6108A<br>P6122<br>P6101A | P6201<br>P6230 | |
| DC 508A | P6125 P6056<br>P6108A | P6230 | |
| DC 510 | P6125 P6056 | | |
| PG 501<br>PG 506<br>PG 507 | P6122 P6062B<br>P6101A P6108A | | |
| PG 502 | P6130 P6062B<br>P6101A | | |
| SC 501<br>SC 502<br>SC 503 | P6101A P6062B<br>P6108A P6007<br>P6015 | | P6021 |
| SC 504 | P6101A P6062B<br>P6108A P6009<br>P6015 P6122 | | P6021<br>P6022 |

**RECOMMENDED PROBES**

Highlighted probes are recommended for typical general-purpose use of the instrument and/or are shipped as a standard accessory to the instrument. See individual probe/instrument specifications for specific applications.

## P6230

### Dc to 1.5 GHz Bias/Offset



**Bias/Offset from −5 V to +5 V**

**Internal/External 50 Ω Termination Switch—Use on Scopes with 50 Ω or 1 MΩ Input**

**Low Impedance**

**Adjustable Tip "Nulling" Voltage**

**Fully Compatible with Tek Subminiature Probe Accessories**

**UL Listed**

The P6230 is a 1.5 GHz, low-impedance, subminiature, 10X active probe for use with broad-band oscilloscopes. The P6230 is equipped with an internal/external 50 Ω termination switch which allows the probe to be used on scopes having an input resistance of either 50 Ω or 1 MΩ. A coding pin on the BNC connector activates the Volts/Division reading by 10X, on oscilloscopes equipped with this feature, so that the correct deflection factor at the probe tip is indicated.

The compensation box of the P6230 houses an active circuit which provides a variable voltage at the probe tip. This voltage is used to minimize probe-loading effects. The voltage available at the tip of the P6230 spans the range from minus five volts to plus five volts, allowing the probe to minimize loading effects on most logic families that are in use today.

The P6230 acts as a standard 500 Ω passive voltage probe with the additional capability of having an adjustable tip "nulling voltage." This feature reduces the dc-loading effects of the probe when it is used to measure signals whose mid-voltage value is other than zero volts, or in circuits where the termination impedance is returned to other than ground level. The Input Bias/Offset Voltage may be adjusted so that at a particular test-signal voltage both ends of the probe input-resistor are at equal potentials and no current is flowing through the resistor.

ECL logic is most commonly operated from a −5.2 V supply with Vcc connected to ground. The output of an ECL gate is the emitter of an NPN emitter follower stage. The output is pulled down to a negative supply (about −2 V) with an external resistor (50 Ω to 100 Ω). Since speed is a major consideration in ECL designs, the interconnections between gates are often transmission lines, and the pull-down resistor doubles as a line termination.

If a standard 500 Ω, 10X probe without the Input Bias/Offset feature were used to examine an ECL output, the probe's 500 Ω resistance to ground would form a voltage divider with the gate's output-termination resistor. This divider can cause distortion of the output signal levels, shift the dc-operation point of the output transistor, and reduce the gate's noise margin.

The dc-load nulling capability of the P6230 helps to solve this problem. By adjusting the Input Bias/Offset Voltage to the ECL low level or to the termination voltage, the only effect of the probe resistance will be a small decrease in the ECL output-termination resistance. The effect of the probe on output voltage levels is negligible.

The probe derives its power from the probe power jack on many Tek scopes, a 1101 or 1101A Power Supply.

## CHARACTERISTICS

### ELECTRICAL CHARACTERISTICS

**Attenuation** — 10X ±3%.

**Loading** — 1.3 pF/450 Ω.

**Bandwidth** — 1.5 GHz.

**Dc Offset Range** — −5 V to +5 V.

**Dc Maximum** — 10 V.

### ENVIRONMENTAL CHARACTERISTICS

**Temperature Range** — Operating: 0°C to +50°C (+32°F to +122°F). Nonoperating: −55°C to +75°C (−67°F to +167°F).

**Humidity** — Five cycles (120 hr) 95% to 97% at 30°C to 60°C. MIL-E-16400F, Class 4.

**Altitude** — Operating: 4600 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

### INCLUDED ACCESSORIES

Alligator ground lead (195-1870-01); microhook ground lead (195-4104-01); low inductance ground lead (195-4240-00); two white marker bands (334-2794-01); two gray marker bands (334-2794-03); protective pouch (016-0708-00); retractable hook tip (013-0208-00); two red marker bands (334-2794-06); two green marker bands (334-2794-07); probe connector (131-2766-03); probe holder (352-0687-00); instruction manual.

## ORDERING INFORMATION

**P6230** 10X, 1.6 m, Bias/Offset Probe. Order 010-6230-01 ..... **$395**

### OPTIONAL ACCESSORIES

**Probe to BNC Adaptor** — Order 013-0195-00 ..... **$9.00**

**50 Ω Probe to GR Adaptor** — Order 017-0520-00 ..... **$48**

**100 ECB Test Points** — Order 131-2766-01 ..... **$22**

**100 ECB Test Connectors** — Order 136-0352-02 ..... **$19.25**

**Subminiature to Miniature Adaptor** — Order 013-0202-00 ..... **$4.00**

### THE FOLLOWING ARE USED WITH 013-0202-00

**Miniature to BNC Adaptor** — Order 013-0084-01 ..... **$8.00**

**50 Ω Miniature to GR Adaptor** — Order 017-0088-00 ... **$50**

**Miniature to Square Pin Adaptor** — Order 015-0325-00 ..... **$15**

**Microcircuit Pincer Tip** — Order 206-0222-00 ..... **$3.50**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. in Oregon call collect: (503) 627-9000, Ext. 99.**

NEW

## P6201 Dc to 900 MHz

**Unity Gain**

**Two Plug-on Attenuator Heads that Maintain Scope Readout Factor**

**Low Input Capacitance**

**Dc Offset**

**Ac-Dc Coupling Switch**

The P6201 is an active (FET) probe providing unity gain and dc to 900 MHz bandwidth. The P6201 is the best general-purpose probe within its voltage range from the standpoint of electrical performance. Very low input capacitance permits acquisition of high frequency signals with minimum loading of circuits under test while high input resistance minimizes low frequency and dc loading. Plug-on attenuator heads provide higher input resistance and reduced input capacitance.

The probe derives its power from the probe power jack on many Tek scopes, a 1101 or 1101A Power Supply.

### CHARACTERISTICS

| | P6201 | P6202A |
|---|---|---|
| Risetime | <0.4 ns | <0.7 ns |
| Bandwidth (verified by risetime) | >900 MHz | >500 MHz |
| Attenuation | X1 | X10 |
| Attenuation Accuracy | ±3% | ±4% |
| Input Resistance | 100 kΩ | 10 MΩ |
| Input Capacitance | 3 pF | 2 pF |
| Input R with Attenuator | 1 MΩ | 10 MΩ*1 |
| Input C with Attenuator | 1.5 pF | 2 pF*1 |
| Dynamic Range | ±0.6 V | ±6.0 V |
| Dynamic Range with Attenuator | ±6 V or ±60 V | ±60 V*1 |
| Dc Offset Range | ±5.6 V | ±55 V |
| Noise | 300 μV | 150 μV |
| Maximum Input Probe Only | ±100 V peak | ±200 V peak |
| Derated above | 60 MHz | 2 MHz |
| Derated to—at Frequency | 5 V at 500 MHz | 20 V at 300 MHz |
| Maximum Input with Attenuator | 200 V peak | 200 V peak*1 |
| Derated above | 50 MHz | 150 MHz*1 |
| Derate to—at Frequency | 5 V at 500 MHz | 70 V at 400 MHz*1 |
| Ac Coupling—3 dB Low Frequency | 10 Hz | 16 Hz |

*1 *Optional accessory.*

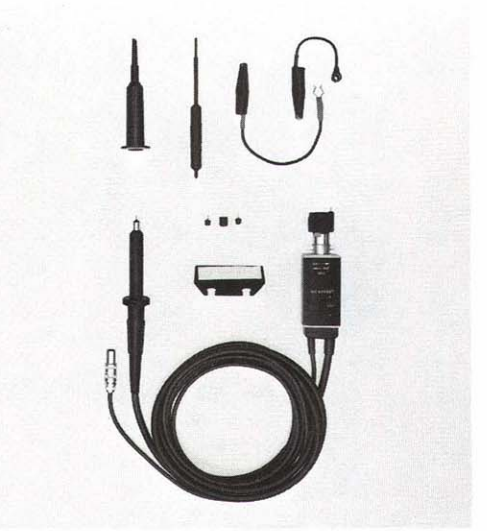
**P6201 INCLUDED ACCESSORIES**

Retractable probe tip (CG, 013-0135-00); 10X attenuator head (010-0376-00); 100X attenuator head (010-0377-00); 3 probe tips (CO, 206-0200-00); probe tip (CJ, 103-0164-00); 30 cm (12 inch) ground lead (DB, 175-0848-02); ground contact (CM,131-1302-00); alligator clip (AS, 344-0046-00); electrical insulating sleeve (CK, 166-0557-00); ground contact insulator (CL, 342-0180-00); carrying case (016-0156-02); instruction manual.

### ORDERING INFORMATION

**P6201** 1X, 6 ft, FET Probe Order 010-6201-01 ..... **$1,210**

## P6202A Dc to 500 MHz



**Dc Offset**

**High Input Impedance through Freq Range**

**Small Probe Size**

With its standard Tektronix power connector the P6202A can be used on any instrument that has standard probe power. The very low input capacitance of the probe permits acquisition of high frequency signals with a minimum loading of circuits under test while the high input resistance minimizes low frequency and dc loading.

The probe has a dc offset feature to offset any dc component within the range of the control to bring the signal into the dynamic range of the probe.

The P6202A derives its power from the probe power jack on many of Tek scopes, a 1101 or 1101A Power Supply.

**INCLUDED ACCESSORIES**

Retractable probe tip (CB, 013-0097-01); two alligator clips (AS, 344-0046-00); probe holder (352-0351-00); 7.5 cm (3 inch) ground ground (DC, 175-0849-00); probe adjustment tool (CP,003-0675-01); carrying case (016-0378-00); 13 cm (6 inch) ground lead (DE, 175-1017-00); two replaceable probe tips*1; electrical insulating sleeve (BP, 166-0404-01); instruction manual.

*1 *Available in package of 10 only. Order 206-0230-03 (CF).*

### ORDERING INFORMATION

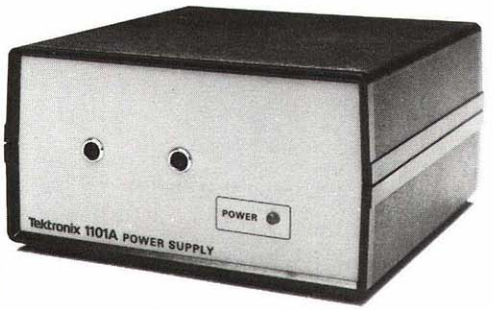
**P6202A** 10X, 2 m, FET Probe Order 010-6202-03 ..... **$675**

**OPTIONAL ACCESSORIES**

**10X Attenuator** — For total 100X attenuation. Order 010-0384-00 ..... **$70**

**Ac Coupling Cap** — Order 010-0360-00 ..... **$34**

## *NEW* 1101A Power Supply




The 1101A Accessory Power Supply provides power for active probes such as the Tektronix P6201, P6202A and P6230 when they are used with oscilloscopes that do not have a probe power supply.

The 1101A will provide power for up to two probes. Output power features short-circuit protection.

### CHARACTERISTICS

**Output Voltages** — +15 V dc ±2%; −15 V dc ±2%; +5 V dc ±5%.

**Output Currents** — 300 mA each supply (short-circuit protected). +15 V, −15 V supplies: ≤1 mV RMS with 300 mA load.

**Ripple** — +5 V Supply: ≤5 mV RMS with 300 mA load.

**Ac Input Voltages** — Selectable, 87 to 128 V ac or 174 to 250 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Power** — 30 W maximum at 115 V ac.

**PHYSICAL CHARACTERISTICS**

| Dimensions | mm | in |
|---|---|---|
| Width | 157 | 6.2 |
| Height | 89 | 3.5 |
| Depth | 165 | 6.5 |
| **Weight** | **kg** | **lb** |
| Net | 1.7 | 3.8 |

### ORDERING INFORMATION

**1101A** Accessory Power Supply ..... **$410**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz
**Option A2** — UK 240 V/13 A, 50 Hz
**Option A3** — Australian 240 V/10 A, 50 Hz
**Option A4** — North American 240 V/15 A, 60 Hz
**Option A5** — Switzerland 220 V/10 A, 50 Hz

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## P6046 Dc to 100 MHz Differential

**1000:1 CMRR at 50 MHz**

**±250 V Maximum Voltage with 10X Attenuator**

**Dual Probe Tips for Greater CMRR at High Frequencies**

The P6046 Differential Probe and P6046 Amplifier Unit provide unique measurement capabilities with all Tektronix oscilloscopes. The differential-signal processing takes place in the probe itself, resulting in high common-mode signal rejection at higher frequencies. Differential probe-tip signal processing minimizes the measurement errors caused by differences in probes, cable lengths, and input attenuators.

### CHARACTERISTICS

**CMRR** — With deflection factors of 1 mV/div to 20 mV/div: at least 10,000:1 at 50 kHz, 5,000:1 at 1 MHz, and 1,000:1 at 50 MHz. **Common-Mode Linear Dynamic Range** — ±5 V, ±50 V with 10X attenuator. **Bandwidth** — Dc to 100 MHz (−3 dB). **Risetime** — 3.5 ns or less. **Deflection Factor Range** — 1 mV/div to 200 mV/div in 8 calibrated steps, 1-2-5 sequence, accurate within 3% (with an oscilloscope deflection factor of 10 mV/div). **Input RC** — 1 MΩ paralleled by 10 pF or less. **Input Coupling** — Ac or dc, selected by a switch on the probe. Low frequency response ac-coupled is −3 dB at 20 Hz, 2 Hz with 10X attenuator. **Displayed Noise** — 280 μV or less (tangentially measured). **Maximum Input Voltage** — ±25 V (dc + peak ac), ±250 V with 10X attenuation, derated with frequency. **Output Impedance** — 50 Ω through a **BNC**-connector. 50 Ω termination supplied with amplifier for use with 1 MΩ systems. **Probe Cable** — 6 ft long, terminated with special nine-pin connector.

#### INCLUDED ACCESSORIES

50 Ω termination (BR, 011-0049-01); amp and power supply (015-0106-00); 50 Ω coaxial cable (012-0076-00); hanger assembly (014-0029-00); carrying case (016-0111-01); 10X attenuator (010-0361-00); dual attenuator head (010-0419-00); swivel probe tip; spring ground contact; connector test point jack; instruction manual.

### ORDERING INFORMATION

**P6046** 1X, 6 ft, FET Differential Probe with Amplifier and Power Supply. Order 010-0232-00 ..... **$1,750**

**Without Amplifier and Power Supply**
Order 010-0213-00 ..... **$60**

**Power Supply with Amplifier**
Order 015-0106-00 ..... **$925**

## P6056 Dc to 3.5 GHz 10X 500 Ω
## P6057 Dc to 1.4 GHz 100X 5000 Ω

**Low Capacitive Loading, 1 pF or Less**

**For 50 Ω Wide Band Scopes**

**<70 ps Probe to Probe Variation**

The P6056 is a miniature low-capacitance probe for use with 50 Ω wide-band oscilloscopes. Bandwidth is dc to 3.5 GHz. This probe can also be used with 50 Ω sampling systems, with an appropriate BNC adaptor. The P6056 is equipped with a special BNC connector that provides trace identification and CRT Readout information when used with plug-in units and mainframes that have these features. A convenient button on the probe activates the trace identification function.

### CHARACTERISTICS

| | P6056 | P6057 |
|---|---|---|
| Risetime | <100 ps | <250 ps |
| Input R @ Dc | 500 Ω | 5 kΩ |
| Input R @ 1 GHz | 300 Ω | 1500 Ω |
| Maximum Dc + Peak Ac | 16 V | 50 V |
| Derated Above | 800 MHz | 500 MHz |
| Maximum Peak @ 1 GHz | 9 V | 21 V |
| Maximum Peak Pulse | 500 V <1 ms | 500 V <1 ms |

#### INCLUDED ACCESSORIES

Alligator clip (AS, 344-0046-00); 75 mm (3 inch) ground lead (DA, 175-0249-00); hook probe tip (BU, 206-0114-00); probe bayonet tip (BM, 013-0085-00); electrical contact (BQ, 214-0283-00); instruction manual.

### ORDERING INFORMATION

**P6056** 10X, 50 Ω Probe
**6 ft — Order 010-6056-03** ..... **$185**
**9 ft — Order 010-6056-05** ..... **$185**

**P6057** 100X, 50 Ω Probe
**6 ft — Order 010-6057-03** ..... **$190**
**9 ft — Order 010-6057-05** ..... **$190**

**Included Accessories with double alpha codes are pictured on pages 456 and 457.**

## P6048 Dc to 200 MHz 10X

**Minimum Loading 1 pF to 1 kΩ**

**Ac/dc Switch**

The P6048 is a miniature low capacitance probe for use with 1 MΩ 20 pF oscilloscopes. The probe input impedance of 1 kΩ paralleled by 1 pF is intended for applications where capacitor loading may distort the circuit waveforms. Ac or dc coupling switch is available to extend the measurement range.

### CHARACTERISTICS

**Attenuation** — 10X.
**Input Resistance** — 1 kΩ.
**Input Capacitance** — 1 pF or less.
**Maximum Input** — Dc 20 V; ac 200 V.
**Ac Low Frequency** — 7 kHz or less.
**Bandwidth** — (With 250 MHz oscilloscope with 1 MΩ/20 pF input) 175 MHz.
**Typical Probe Risetime** — 1.95 ns.

#### INCLUDED ACCESSORIES

Bayonet probe tip (BM, 013-0085-00); retractable probe hook tip (CA, 013-0090-00); two electrical insulating sleeves (BP,166-0404-01); two alligator clips (AS, 344-0046-00); 13 cm (5 inch) ground lead (175-0124-01); insulating sleeve ground lead (CN, 166-0433-00); probe tip hook (BU, 206-0114-00); 7.5 cm (3 inch) ground lead (DD, 175-0263-01); probe holder (352-0090-00); instruction manual.

### ORDERING INFORMATION

**P6048** 10X, 6 ft, Probe. Order 010-0215-00 ..... **$205**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## P6602 Temperature Probe

### UL Listed

The P6602 Temperature Probe is a temperature measuring device designed to operate with the 2236 Digital Multimeter. The temperature sensory element consists of a thin-film platinum resistor in the tip of the probe. Measurements are made by touching the probe tip to the surface under test. The resulting resistor value is measured by the multimeter through a two-conductor cable. The tip and cable assembly are replaceable.

### CHARACTERISTICS

**Operating Temperature Range** — Probe Head and Cable: −62°C to +230°C (−80°F to +446°F). Banana Jack Style Connector: −15°C to +85°C.

**Voltage** — 400 V peak.

**Included Accessory** — Instruction manual.

### ORDERING INRORMATION

**P6602** 1.5 m Temperature Probe. Order 010-6602-00 ..... **$225**

## P6401 Logic Probe

### Illuminated Probe Tip Indicates Logic Level

The small, lightweight, hand-held P6401 indicates the state of logic levels in TTL, DTL, or any other system with threshold between 0.7 and 2.15 volts. A strobe input can be used to detect the coincidence of logic signals at two points. An indication of whether a logic pulse has or has not occurred can be obtained in a "store" mode.

Power may be obtained from the unit under test or any five volt supply.

Two bright lights in the probe tip indicate condition of the logic signal.

### CHARACTERISTICS

**POWER SUPPLY**

**Low State Input Voltage Range** — 0 V to +0.7 V ±0.125 V.

**High State Input Voltage Range** — 2.175 V ±0.125 V to V cc.

**Minimum Recognizable Pulse Width** — 10 ns.

**Impedance** — ≈7.5 kΩ paralleled by ≈6 pF.

**Minimum Circuit Resistance for Open Circuit Indication** — 10 kΩ.

**Maximum Safe Input** — ±150 V (dc or RMS).

**Minimum Recognizable Strobe Pulse Width** — 20 ns.

**Maximum Safe Strobe Input** — ±30 V (dc or RMS).

**Strobe Input Impedance** — 5.6 kΩ within 20%.

**INCLUDED ACCESSORIES**

Probe tip hook (BU, 206-0114-00); strobe lead (175-0958-01); strobe lead (175-0958-00); probe tip to 0.025 inch square pin adaptor (AH, 206-0137-01); white plug (348-0023-00); two alligator clips (AS, 344-0046-00); accessory pouch (016-0537-00); instruction manual.

### ORDERING INFORMATION

**P6401** 1.5 m Logic Probe. Order 010-6401-01 ..... **$170**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## P6420 RF Probe

### 10 kHz to 1 GHz Bandwidth

### Dc V output/RMS of Sine Input

The P6420 RF probe measures high frequency ac voltage from 10 kHz to 1 GHz. It provides a dc output voltage proportional to the RMS value of a sinewave input compatible with any DMM with an input resistance of 10 MΩ.

#### CHARACTERISTICS

**Voltage Range** — 0.5 V to 25 V RMS (70.7 V p-p).

**Ac to Dc Transfer Ratio Accuracy** — 0.5 V to 5 V RMS ±10% (+15°C to +35°C). 5.0 V to 25 V RMS ±5% (+15°C to +35°C).

**Frequency Response** — 100 kHz to 300 MHz (±0.5 dB). 50 kHz to 500 MHz (±1.5 dB), 10 kHz to 1 GHz (±3.0 dB).

**Input Capacitance** — ≈3.7 pF.

**Maximum Input Voltage** — 42.4 V (peak ac + dc).

**Temperature Range** — Nonoperating: −55°C to +75°C. Operating: +15°C to +35°C.

**Length** — Probe Only: 96 mm. Cable Only: 2 m.

#### INCLUDED ACCESSORIES

Retractable probe tip (CB, 013-0097-01); two alligator clips (AS, 344-0046-00); two replaceable*[1] probe tips; electrical insulating sleeve (BP, 166-0404-01); 75 mm (3 inch) ground lead (DC, 175-0849-00); 130 mm (6 inch) ground (DE, 175-1017-00); probe holder (352-0351-00); BNC female to dual banana adaptor (103-0090-00); instruction manual.

*[1] *Available in packages of ten (order 206-0230-03) or* 100 (order 206-0230-04) *(CF).*

#### ORDERING INFORMATION

**P6420** 2 m, RF Probe. Order 010-6420-03 ..... **$145**

#### OPTIONAL ACCESSORIES

Probe cables usable with the P6420 (does not change electrical specifications): Price available upon request.

**1 m** — Order 175-9419-00
**2 m** — Order 175-9409-00
**3 m** — Order 175-9410-00

## P6008 (Environmental) 10X 100 MHz

### −50°C to +150°C Temperature Range

The P6008 Environmental Probe is designed to operate over −50°C to +150°C for the probe body and cable; the compensation box operates from −15°C to +55°C. It is designed for use with Tektronix dc to 100 MHz oscilloscopes. The probe can be compensated to match Tektronix plug-ins and oscilloscopes with nominal input capacitance of 12 pF to 47 pF and input resistance to 1 MΩ.

#### CHARACTERISTICS

**Attenuation** — 10X.

**Input Resistance** — 10 MΩ.

**Input Capacitance** — ≈7.5 pF when used with an instrument having a 20 pF input capacitance.

**Bandwidth** — Dc to 100 MHz.

**Voltage Rating** — 600 V dc, ac peak, or dc and ac peak combined. P-p voltage derating is necessary for cw frequencies higher than 20 MHz. At 40 MHz, the maximum allowable p-p voltage is 300 V.

**Cable Length** — 1.8 m (6 ft).

#### INCLUDED ACCESSORIES

Banana tip (AK, 134-0013-00); 300 mm (12 in) ground lead (BD, 175-0125-01); alligator clip (AR, 344-0045-00); retractable hook tip (AP, 013-0071-00); instruction manual.

#### ORDERING INFORMATION

**P6008** 10X, 6 ft, Environmental Probe. Order 010-0129-01 ..... **$220**

**Included Accessories with double alpha codes are pictured on pages 456 and 457.**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## A6302/AM 503 Current Probe

**20 A Ac and Dc Current Measurements**

**Dc to 50 MHz Bandwidth**

**Peak Pulse Measurements to 50 A, 50,000 A with the CT-5 Current Probe**

**Ac or Dc Coupling**

**Small Loading—0.1 Ω Insertion Z at 1 MHz, 0.5 Ω at 50 MHz**

The Tektronix A6302 and A6303 Current Probes are designed to be used with the AM 503 Current Probe Amplifier, any TM 500 Power Module and an oscilloscope. Both probes are used to make SCR, power supply, industrial control and motor start-up current measurements. The A6303 is especially recommended for measuring current in x-ray tubes to ensure compliance with PL 90-602, the Radiation Control for Health and Safety Act of 1968.

The A6302 and A6303 are valuable measurement tools when low loading is important, as when testing high impedance points or with current dependent devices.

Both probes make ac or dc coupled current measurements by the simple act of opening their sliding jaws and placing them around the conductor to be measured. For differential or sum measurements just place properly phased conductors in the probe jaw.

Suggested measurements for the A6302 and A6303 Current Probes include:
X-ray tube currents
SCR currents
Power supply currents
Motor start-up currents
Industrial control currents
Relay currents
Common-mode rejection of dc and ac currents

## A6303/AM 503 Current Probe

**100 A Ac and Dc Current Measurements**

**Peak Pulse Measurement to 500 A**

**Ac or Dc Coupling**

**25 x 21 mm (1 x 0.83 inch) Jaw Opening**

**Minimal Loading—0.02 Ω Insertion at 1 MHz, 0.15 Ω at 15 MHz**

### CHARACTERISTICS

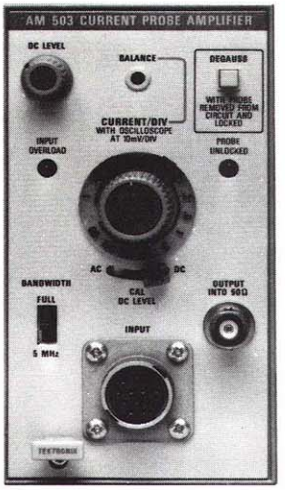
| | A6302 & AM 503 | A6303 & AM 503 |
|---|---|---|
| Sensitivity Scope @ 10 mV/div Accuracy 3% | 1 mA/div to 5 A/div | 10 mA/div to 50 A/div |
| Bandwidth | Dc to 50 MHz | Dc to 15 MHz |
| Risetime | 7 ns | 23 ns |
| Max Ac Current CW | 40 A p-p | 200 A p-p |
| Derated above | 20 kHz 2.5 A @ 10 MHz | 20 kHz 12 A @ 10 MHz |
| Maximum Current Peak Not to Exceed A-S product | 50 A | 500 A |
| A-S Product | 100 x $10^{-6}$ | 10,000 x $10^{-6}$ |
| Insertion Z | 0.1 Ω @ 5 MHz 0.5 Ω @ 50 MHz | 0.02 Ω @ 1 MHz 0.15 Ω @ 15 MHz |
| Max Hardware Volts | 500 V | 700 V |
| Max Conductor Diameter | 0.15 inch | 0.83 inch |
| System Prop Delay | ≈30 ns | ≈40 ns |
| Cable Length | 2 m | 2 m |
| Tangential Noise | 0.3 mA | 3 mA |
| Aberrations | ±5% | ±5% |
| Magnetic Susceptability | 250 μA/Gauss | 25 mA/Gauss |
| Operating Temp | 0°C to +50°C | 0°C to +50°C |

**INCLUDED ACCESSORIES**

A6303 only: carrying case (016-0622-00); instruction manual. A6302 only: miniature alligator clips (AS, 344-0046-00); 130 mm (5 in) probe ground lead (DD, 175-0124-01); 75 mm (3 in) probe ground lead (DD, 175-0263-01); instruction manual.

### ORDERING INFORMATION

**A6303** 2 m, Current Probe ..... **$1,060**
**A6302** 2 m, Current Probe ..... **$560**




## AM 503 Current Probe Amplifier

The AM 503 Current Probe Amplifier operates in any one of the TM 500 power modules and is connected to either the A6302 or A6303 probes through a multi-pin connector.

It is calibrated in 12 steps; the knob skirt is illuminated to indicate current per division. Bandwidth can be limited to 5 MHz to eliminate unwanted transients. Both ac and dc coupling are provided. Ac coupling allows the measurement of low amplitude signals on a high-level dc current. A front-panel light warns of input currents above 100 A dc with the A6303 or 20 A dc with the A6302. A push button allows degaussing of probe when it is removed from the circuit and locked in operating position.

The output of the A6303/AM 503 can be displayed on any oscilloscope that has at least a 50 MHz bandwidth and a 10 mV sensitivity. The A6302/AM 503 can be used on a 75 MHz oscilloscope with 10 mV sensitivity to display the probe's full bandpass. The AM 503 output can be plugged directly into a 50 Ω recording instrument, or a 50 Ω termination which is supplied. See page 388 for a complete description of the AM 503.

**INCLUDED ACCESSORIES**

50 Ω BNC cable (012-0057-01); 50 Ω BNC termination (BR, 011-0049-01); instruction manual.

### ORDERING INFORMATION

**AM 503** Current Probe Amplifier ..... **$1,115**

The AM 503 Current Probe Amplifier requires one of the TM 500 Series power modules listed below. The number of plug-ins the module will accept is designated by the last digit in the part number. The optional interface allows connections between plug-ins to be made through the rear panel of the power module.

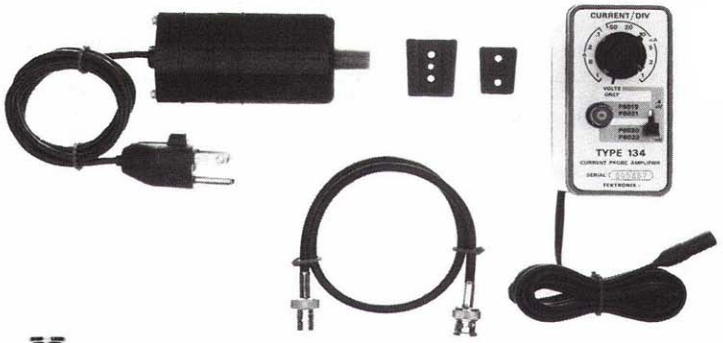
**TM 501** Power Module ..... **$350**
**Option 02** — Interface ..... **+$60**
**TM 503** Power Module ..... **$350**
**Option 02** — Interface ..... **+$90**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## P6021 w/Term

## P6022 w/Term

## 134 Current Probe Amplifier



### Clip-on Capability

### Shielded Probe Heads

The P6021 and P6022 Current Probes and 134 Current Probe Amplifier provide versatility in a user-assembled ac current measurement system. Both probes provide accurate current measurements over a wide range of frequencies and are used with real-time oscilloscopes. The P6021 and P6022 can be used with 1 MΩ input instruments with their passive terminations, or with 50 Ω and 1 MΩ input instruments with the 134 Amplifier. Both the P6021 and P6022 avoid breaking a circuit by clipping on to a conductor. Just open the spring-loaded slide, place the conductor into the slot and release the slide. No electrical connection is required.

Shielded probe heads are not grounded when the slides are in their open positions, eliminating accidental grounding of the circuit under test.

**P6021 Current Probe**

For general purpose applications the P6021 Current Probe provides wide-band performance with excellent low-frequency characteristics. P6021 bandwidth is 120 Hz to 60 MHz. Passive termination is switchable from 2 mA/mV to 10 mA/mV.

**P6022 Current Probe**

The extra small size of the P6022 Current Probe makes it ideally suited to measure current in compact semiconductor circuits. P6022 bandwidth is 935 Hz to 120 MHz. Passive termination is switchable from 1 mA/mV to 10 mA/mV.

The 134 is used to extend the measurement capabilities and sensitivity of the P6021 or P6022 Current Probe. A Current/Div switch provides calibrated current steps from 1 mA/div to 1 A/div (with the oscilloscope or plug-in unit adjusted for a deflection factor of 50 mV/div). A passive termination is not required when using a 134 with a P6021 or P6022.

The 134 can also be used as an auxiliary voltage amplifier by placing the Current/Div switch in the Volts position.

**INCLUDED ACCESSORIES (134)**

Hanger assembly (014-0029-00); 110 V power supply (015-0058-01); cable assembly (012-0104-00); 230 V power supply (015-0059-01); instruction manual.

**INCLUDED ACCESSORIES (P6021 and P6022)**

13 cm (5 inch) ground lead (DD, 175-0125-01); two alligator clips (AS, 344-0046-00); 7.5 cm (3 inch) ground lead (DD,175-0263-01); instruction manual.

### PERFORMANCE CHARACTERISTICS

| | P6021 with Passive Termination | | P6022 with Passive Termination | | Probe with 134 Amplifier | |
|---|---|---|---|---|---|---|
| | | | | | P6021 | P6022 |
| Accuracy 3% Sensitivity | 2 mA/mV | 10 mA/mV | 1 mA/mV | 10 mA/mV | 1 mA to 1 A/div @ 50 mV/div | |
| Bandwidth | | | | | | |
| Low −3 dB | 450 Hz | 120 Hz | 8.5 kHz | 935 Hz | 12 Hz | 100 Hz |
| High −3 dB | 60 MHz | 60 MHz | 100 MHz | 120 MHz | 38 MHz | 65 MHz |
| Risetime | 5.8 ns | 5.8 ns | 2.7 ns | 1.7 ns | 9.2 ns | 5.4 ns |
| Droop TC | 0.35 ms | 1.3 ms | 18.7 μs | 0.17 ms | 13 ms | 1.6 ms |
| Maximum Ac CW | 15 A peak | 15 A peak | 6 A peak | 6 A peak | 15 A peak | 6 A peak |
| From | 1.2 kHz | 300 Hz | 10 kHz | 3 kHz | 230 Hz | 1.3 kHz |
| To | 5 MHz | 5 MHz | 10 MHz | 10 MHz | 5 MHz | 10 MHz |
| Maximum Peak Current | 250 A | 250 A | 100 A | 100 A | 250 A | 100 A |
| Amp/Second Product | 500 x $10^{-6}$ | 500 x $10^{-6}$ | 9 x $10^{-6}$ | 9 x $10^{-6}$ | 500 x $10^{-6}$ | 9 x $10^{-6}$ |
| Maximum Dc | 0.5 A | 0.5 A | 0.5 A | 0.5 A | 0.5 A | 0.5 A |
| Insertion Z (Ω) | 0.03 @ 1 MHz<br>1.0 @ 60 MHz | | 0.03 @ 1 MHz<br>0.2 @ 120 MHz | | 0.03 @ 1 MHz<br>1.0 @ 38 MHz | 0.03 @ 1 MHz<br>0.2 @ 65 MHz |
| Propagation Delay (ns) | | | | | | |
| 5 ft | 9 | 9 | 9 | 9 | 9 | 9 |
| 9 ft | 15 | 15 | 15 | 15 | 15 | 15 |
| Maximum Voltage Barewire | 600 V | 600 V | 600 V | 600 V | 600 V | 600 V |
| Net Weight | ≈1 lb | | ≈1 lb | | ≈5 lb | |
| Maximum Conductor Size | 0.15 in dia | | 0.1 in dia | | 0.15 in dia | 0.1 in dia |
| Operating Temperature | 0°C to +50°C | | 0°C to +50°C | | 0°C to +50°C | |

### ORDERING INFORMATION

**P6021**

**P6021** Current Probe, Term and 5 ft Cable. Order 015-0140-02 ..... **$388**
**9 ft Cable and Term.** Order 015-0140-03 **$388**
**5 ft Cable w/o Term.** Order 010-0237-02 **$335**
**9 ft Cable w/o Term.** Order 010-0244-02 **$335**

**P6022**

**P6022** Current Probe, Term, and 5 ft Cable. Order 015-0135-00 ..... **$430**
**9 ft Cable and Term.** Order 015-0135-01 **$430**
**5 ft Cable w/o Term.** Order 010-0238-00 **$345**
**9 ft Cable w/o Term.** Order 010-0238-02 **$345**

**134**

**134** Current Probe Amplifier. Order 015-0057-02 ..... **$625**
**Option 04** — 230 V ac. Order 015-0057-03 ..... **$675**

**OPTIONAL ACCESSORIES (for P6021, P6022, and 134)**

**Calibrator Adaptor** — BNC. Order 013-0092-00 ..... **$35**
**Carrying Case** — For P6021 or P6022, and a 134 Amplifier. Order 016-0087-01 ..... **$25**
**Passive Termination** — For P6021. Order 011-0105-00 **$95**
**Passive Termination** — For P6022. Order 011-0106-00 . **$115**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## CT-1/CT-2 Current Probes

**The 1 GHz CT-1 is Used with 50 Ω Systems, or Wide Band Oscilloscopes, It has a Minimum Loading Effect on a 50 Ω Environment**

**The CT-2 is Used with Oscilloscopes Up To 100 MHz Bandwidth, It is Insulated for Limited Space Applications**

The CT-1 and CT-2 Current Probes are designed for permanent or semi-permanent in-circuit installation. Each probe consists of a current transformer, an interconnecting cable and a termination. The current transformers are traversed by a small hole through which a current carrying conductor is passed during circuit assembly.

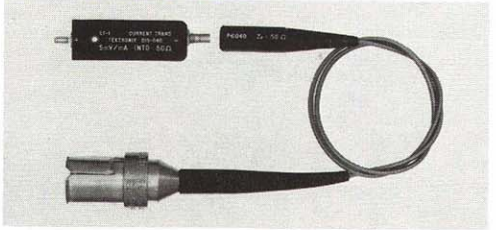
One probe cable can be used to monitor several current transformers that have been wired into a circuit.

### CHARACTERISTICS

| | CT-1 | CT-2 |
|---|---|---|
| Sensitivity | 5 mV/mA | 1 mV/mA |
| Accuracy | ±3% | ±3% |
| Risetime | 350 ps | 500 ps |
| Frequency Response | | |
| Low: −3 dB | 25 kHz | 1.2 kHz |
| High: −3 dB | 1 GHz | 200 MHz |
| Decay Time Constant: L/R | 6.35 μs | 160 μs |
| Insertion Impedance: | | |
| at 10 MHz | ≈1 Ω | 0.1 Ω |
| at 100 MHz | 2 Ω | 0.5 Ω |
| Capacitive Loading Barewire | 1.5 pF for #14 | 1.8 pF for #16 |
| Maximum Barewire Voltage | 1000 V | 1000 V |
| Dc Saturation Current: | | |
| Current to Reduce L/R by X2 | 75 mA | 175 mA |
| Pulse Current Rating*1 | 12 A | 36 A |
| Not to Exceed: | | |
| Amp S Product*1 | 1 x $10^{-6}$ | 50 x $10^{-6}$ |
| Maximum CW Current*1 | 450 mA | 2.5 A |
| Cable Length | 18 inch | 42 inch |
| Prop Delay | 3.25 ns | 6.1 ns |
| Cable Connector | GR874 | BNC |
| Operating Temperature | −25°C to +65°C | |

*1 *With 50 Ω termination. Values are reduced by a factor of 2 if unterminated.*

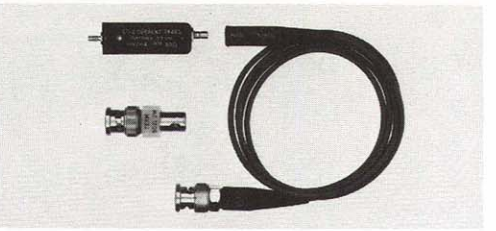
### CT-1 with Probe Cable



The CT-1 Probe Cable (010-0133-00) provides the connection between the CT-1 current transformer and a GR scope input. This cable can also be used with other test point connectors such as Amphenol Series 27 Sub-Minax or Sealectro Sub-Miniature RF connectors.

**Included Accessories** — Instruction manual.

### CT-2 with Probe Cable



The CT-2 Probe Cable (010-0164-00) is used to connect the CT-2 current transformer with a BNC oscilloscope input. A 50 Ω termination is used to terminate the cable at the high impedance input of an oscilloscope.

**INCLUDED ACCESSORIES (CT-2)**

50 Ω termination (BR, 011-0049-01); instruction manual.

### ORDERING INFORMATION

**CT-1** Current Transformer and Probe Cable. Order 015-0041-00 ..... **$160**

**CT-1** Current Transformer Only. Order 015-0040-00 ..... **$95**

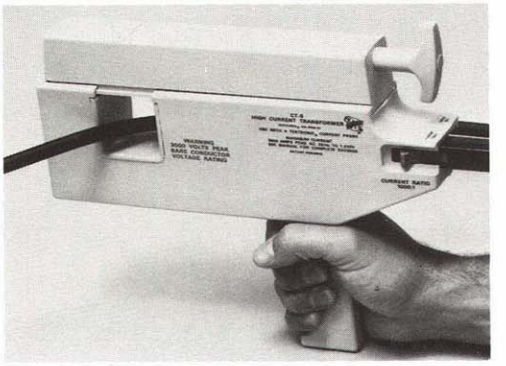
**CT-1** Probe Cable Only (P6040). Order 010-0133-00 ..... **$80**

**CT-2** Current Transformer, Probe Cable and Termination. Order 015-0047-00 ..... **$180**

**CT-2** Current Transformer Only. Order 015-0046-00 ..... **$110**

**CT-2** Probe Cable Only (P6041). Order 010-0164-00 ..... **$60**

## CT-5 Continuous Currents to 1000 A



**1.5 Inch Diameter Conductors**

**Measurements on Bare Conductors to 3000 V**

**Nullifies Dc Effects to 300 A w/Dc Bucking Coil**

**Pulsed Currents to 50 kA**

The CT-5 is a clip-on high-current transformer that extends the measurement capability of the Tektronix P6021 and A6302 clip-on current probes. Maximum low-frequency performance is obtained using the A6302/AM 503 Dc Current Probe. Pulse current to 50,000 amps may be measured using the P6021 and passive termination, provided the 0.5 A-s rating is not exceeded. The P6021 and 134 Current Probe Amplifier may also be used for measurements at normal line frequency and above. (The P6022 and CT-5 are not compatible with each other.) The CT-5 has receptacles for current probes in either 20:1 or 1000:1 step-down ratios. The 1.5 inch square opening makes it possible to clip onto large conductors without breaking the circuit under test. The core and shield assembly are insulated from the windings and the handle. This allows measurements on bare wires to 3000 V, and to 10 kV RMS with a high voltage bushing.

A dc bucking coil assembly allows up to 300 A of dc to be tolerated without appreciably degrading measurements. This is very useful for measuring ac signals on top of a dc voltage level.

### CHARACTERISTICS (CT-5)

The following are characteristics of the CT-5 using either the A6302/AM 503 or P6021/134 combinations.

**Risetime** — 17.5 ns or less.

**Insertion Impedance** — ≤20 μΩ at 60 Hz; 20 mΩ at 1 MHz.

**Current Range** — 20 mA/div to 100 A/div with A6302/AM 503, and 20 mA/div to 20 A/div with P6021/134 (20:1 step down ratio); 1 A/div to 5 kA/div with A6302/AM 503, 1 A/div to 1 kA/div with P6021/134, (1000:1 step down ratio).

**Accuracy** — ±4%. Maximum Current is 1000 A peak cw.*1

**Amp-S product** — 8 A-s.

**Maximum Voltage** — Of circuit test is 3000 V (barewire).

**Maximum Dc Bucking Current** — 300 mA to buck out 300 A dc (using dc bucking coil).

*1 *Maximum current 1000 A peak from 20 Hz to 1.2 kHz derating to 100 A peak at 1 MHz.*

**CT-5 CURRENT MEASUREMENT COMBINATIONS**

| Product | Bandwidth | A-s Product | Maximum Current RMS | Maximum Current Peak Pulse |
|---|---|---|---|---|
| CT-5/A6302/AM 503 | 0.5 Hz to 20 MHz | 0.1 | 700 A | 50 kA |
| CT-5/P6021/134 | 12 Hz to 20 MHz | 0.5 | 700 A | 15 kA |
| CT-5/P6021/Term | 120 Hz to 20 MHz | 0.5 | 700 A | 50 kA |

**PHYSICAL CHARACTERISTICS**

| Dimensions | mm | in |
|---|---|---|
| Width | 57 | 2.3 |
| Height | 241 | 9.5 |
| Depth | 266 | 10.5 |
| **Weight** | **kg** | **lb** |
| Net | 1.8 | 4.0 |

**INCLUDED ACCESSORIES**

Carrying case (016-0191-03); 12 in wide, 4 ft long high voltage bushing (015-0194-00); instruction manual.

### ORDERING INFORMATION

**CT-5** Current Probe (Includes Dc Bucking Coil). Order 015-0189-01 ..... **$1,150**

Without Dc Bucking Coil. Order 015-0189-00 ..... **$1,050**

**OPTIONAL ACCESSORIES**

**Dc Bucking Coil.** Order 015-0190-00 ..... **$300**

**High-Voltage Bushing** — 12 in wide, 4 ft long. Order 015-0194-01 ..... **$43**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## Improved Modular Probes

**Doubled Cable Flex Life, Increased Flexibility**

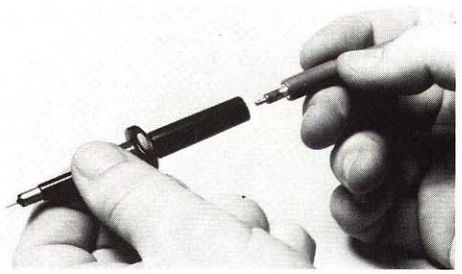
**Stronger Probe Tips, Lower Input C**

**Improved Attenuation Accuracy**

**Decreased Aberrations**

**Improved Humidity Characteristics**

Modular probes are an exciting new concept in probe design. Our entire modular probe line is improved, incorporating a new design and hybrid circuitry for a better probe. The P610X and P6149 probes are now designated with an "A" (i.e., P6105A) to indicate the improved version. The P6121, P6122, P6130, and P6131 also feature the improvements but remain nomenclated as before.



### MODULAR PROBE CHARACTERISTICS

| Probe | Atten | Length (m) | Loading | | BW MHz at −3 dB | Dc Maximum | Scope in pF | Readout | Package Number | Instrument Compatibility | Page |
|---|---|---|---|---|---|---|---|---|---|---|---|
| P6101A | 1X | 1<br>2<br>3 | 1 MΩ | 32.0 pF<br>54.0 pF<br>78.0 pF | 34<br>15.5<br>8 | 500 V*1 | ANY | NO | 010-6101-11<br>010-6101-13<br>010-6101-15 | 5000 Series; 7A13, 7A15A, 7A16A, 7A18A, 7A22; 2300 Series; 2200 Series; 400 Series; T900 Series; AM 502, DC 509, PG 501, PG 502, PG 506, PG 507, SC 501, SC 502, SC 503, SC 504 | 450 |
| P6105A | 10X | 1<br>2<br>3 | 10 MΩ | 8.7 pF<br>11.2 pF<br>13.2 pF | 100<br>100<br>90 | 500 V*2 | 15 to 35<br>15 to 35<br>15 to 30 | YES | 010-6105-11<br>010-6105-13<br>010-6105-15 | 5A38, 5A45, 5A48, 5D10,7A13, 7A15A, 7A18A; 465, 455, 390AD | 450 |
| P6106A | 10X | 1<br>2<br>3 | 10 MΩ | 8.7 pF<br>11.2 pF<br>13.2 pF | 250<br>250<br>150 | 500 V*2 | 15 to 35<br>15 to 35<br>15 to 30 | YES | 010-6106-11<br>010-6106-13<br>010-6106-15 | 7A16A, 485, 475A, 475 | 450 |
| P6107A | 10X | 2 | 10 MΩ | 13.0 pF | 100 | 500 V*2 | 20 to 51 | YES | 010-6107-13 | 306 | 450 |
| P6108A | 10X | 1<br>2<br>3 | 10 MΩ | 8.7 pF<br>11.2 pF<br>13.2 pF | 100<br>100<br>90 | 500 V*2 | 15 to 35<br>15 to 35<br>15 to 30 | NO | 010-6108-11<br>010-6108-13<br>010-6108-15 | 5A14N; 2300 Series; 434, T900 Series; DC 503A, DC 504,DC 505A, DC 508A, DC 509, SC 501, SC 502, SC 503, SC 504 | 450 |
| P6149A | 10X | 2 | 10 MΩ | 15.5 pF | 50 | 500 V*2 | 20 to 51 | NO | 010-6149-13 | 305, 314, 323, 326, 335, 336 | 450 |
| P6121 | 10X | 1.5 | 10 MΩ | 11.0 pF | 100 | 500 V*2 | 20 to 26 | YES | 010-6121-01 | Specifically 2236 | 451 |
| P6122 | 10X | 1.5<br>2<br>3 | 10 MΩ<br>10 MΩ<br>10 MΩ | 11.0 pF<br>12.0 pF<br>14.0 pF | 100<br>100<br>90 | 500 V*2 | 15 to 35<br>15 to 35<br>15 to 30 | NO | 010-6122-01<br>010-6122-03<br>010-6122-05 | 5A38, 5A45, 5A48, 7A13, 7A15A, 7A18A, 2213A, 2215A; 2235; 390AD; T900 Series; DC 5009, DC 503A, DC 504, DC 505A, DC 509; PG 501, PG 506, PG 507; SC 504 | 451 |
| P6130 | 10X | 1.5<br>2<br>3 | 10 MΩ | 12.7 pF<br>13.2 pF<br>14.5 pF | 250<br>250<br>150 | 500 V*2 | 15 to 35<br>15 to 35<br>15 to 30 | YES | 010-6130-01<br>010-6130-03<br>010-6130-05 | 7A15A, 7A16A, 7A18A, 7A26, 2300 Series, 485, 475A, 475, 465B, 465, 468, 465M, 466, 464, DC 5010; PG 502 | 452 |
| P6131 | 10X | 1.5<br>2<br>3 | 10 MΩ | 10.8 pF<br>13.5 pF<br>14.5 pF | 300<br>250<br>150 | 500 V*2 | 14 to 18 | YES | 010-6131-01<br>010-6131-03<br>010-6131-05 | Specifically 2445/2465 and 7A42 | 452 |

*1 Maximum Input Voltage is 500 V dc + peak ac to 300 kHz derated to 20 V at 30 MHz. *2 Maximum Input Voltage is 500 V dc + peak ac to 1.3 MHz derated to 50 V at 100 MHz.

The P6101A, P6105A, P6108A, P6106A, P6107A, P6149A, P6121, P6122, P6130, P6131 probes divide into three modules (probe heads, cables, and connector/compensation boxes). The modules snap or screw together, making maintenance and repair less expensive, faster and easier.

The P6101A, P6105A, P6106A, P6107A, P6108A, P6149A probes are used to acquire high fidelity signals from low source-impedance circuits. The P6105A and P6106A are designed for oscilloscopes equipped vertical scale or CRT readout. These probes will automatically scale the readout by a factor of ten. The P6149A and P6107A feature a right angle BNC connector.

The P6121 and P6122 probes are miniature, 10X passive probes. The P6121 is designed specifically for use with the Tektronix 2236 portable oscilloscope. The P6122 is a general purpose probe which accommodates oscilloscopes with bandwidths up to 100 MHz.

The P6130 and P6131 probes are subminiature 10X passive probes. The P6130 is a general purpose probe which accommodates oscilloscopes with bandwidths up to 250 MHz. P6131 is specifically designed for use with the Tektronix 2445/2465 and 7A42.

**Compatability Between Previous Versions and Improved Versions**

All cables are compatible between the previous and "A" version probes. Compensation boxes and probe heads are not compatible between the two versions due to the hybrid circuitry used. A complete reference listing for replacement parts follows.

### MODULAR PROBE REPLACEMENT PARTS

| Probe | Length (m) | Connector | | Probe Cable | | Probe Head | | Probe Tip | |
|---|---|---|---|---|---|---|---|---|---|
| P6101 | 1 | 103-0189-00 | $18.50 | 175-1661-00 | $27.00 | 206-0223-00 | $20.00 | 206-0191-03*1 | $17.00 |
| | 2 | 103-0189-00 | $18.50 | 175-1661-01 | $27.00 | 206-0223-00 | $20.00 | 206-0191-03*1 | $17.00 |
| | 3 | 103-0189-00 | $18.50 | 175-1661-02 | $27.00 | 206-0223-00 | $20.00 | 206-0191-03*1 | $17.00 |
| P6101A | 1 | 103-0189-00 | $18.50 | 175-9419-00*4 | | 206-0223-02*4 | | 206-0191-03*1 | $17.00 |
| | 2 | 103-0189-00 | $18.50 | 175-9409-00*4 | | 206-0223-02*4 | | 206-0191-03*1 | $17.00 |
| | 3 | 103-0189-00 | $18.50 | 175-9410-00*4 | | 206-0223-02*4 | | 206-0191-03*1 | $17.00 |
| P6104 | 1 | 206-0244-00 | $35.00 | 175-1661-00 | $27.00 | 206-0244-00 | $35.00 | 206-0191-03*1 | $17.00 |
| P6104A | 1 | 206-0332-00*4 | | 175-9419-00*4 | | 206-0303-00*4 | | 206-0336-01*2*4 | |
| P6105 | 1 | 206-0219-02 | $48.00 | 175-1661-00 | $27.00 | 206-0216-00 | $48.00 | 206-0191-03*1 | $17.00 |
| | 2 | 206-0220-02 | $48.00 | 175-1661-01 | $27.00 | 206-0217-00 | $48.00 | 206-0191-03*1 | $17.00 |
| | 3 | 206-0221-02*4 | $33.00 | 175-1661-02 | $27.00 | 206-0218-00 | $48.00 | 206-0191-03*1 | $17.00 |
| P6105A | 1 | 206-0331-00*4 | | 175-9419-00*4 | | 206-0328-00*4 | | 206-0336-01*2*4 | |
| | 2 | 206-0334-00*4 | | 175-9409-00*4 | | 206-0301-00*4 | | 206-0337-01*2*4 | |
| | 3 | 206-0320-02*4 | | 175-9410-00*4 | | 206-0302-00*4 | | 206-0338-01*2*4 | |
| P6106 | 1 | 206-0237-02 | $65.00 | 175-1661-00 | $27.00 | 206-0216-00 | $48.00 | 206-0191-03*1 | $17.00 |
| | 2 | 206-0238-02 | $70.00 | 175-1661-01 | $27.00 | 206-0217-00 | $48.00 | 206-0191-03*1 | $17.00 |
| | 3 | 206-0239-00 | $70.00 | 175-1661-02 | $27.00 | 206-0218-00 | $48.00 | 206-0191-03*1 | $17.00 |
| P6106A | 1 | 206-0313-01*4 | | 175-9419-00*4 | | 206-0328-00*4 | | 206-0336-01*2*4 | |
| | 2 | 206-0319-01*4 | | 175-9409-00*4 | | 206-0301-00*4 | | 206-0337-01*2*4 | |
| | 3 | 206-0320-01*4 | | 175-9410-00*4 | | 206-0302-00*4 | | 206-0338-01*2*4 | |
| P6107 | 2 | 206-0247-00 | $42.00 | 175-1661-01 | $27.00 | 206-0217-00 | $48.00 | 206-0191-03*1 | $17.00 |
| P6107A | 2 | 206-0247-02*4 | | 175-9409-00*4 | | 206-0217-02*4 | | 206-0339-02*2*4 | |
| P6108 | 1 | 206-0227-03 | $30.00 | 175-1661-00 | $27.00 | 206-0224-00 | $41.00 | 206-0191-03*1 | $17.00 |
| | 2 | 206-0228-00 | $48.00 | 175-1661-01 | $27.00 | 206-0225-00 | $41.00 | 206-0191-03*1 | $17.00 |
| | 3 | 206-0229-03 | $35.00 | 175-1661-02 | $27.00 | 206-0226-00 | $41.00 | 206-0191-03*1 | $17.00 |
| P6108A | 1 | 206-0332-01*4 | | 175-9419-00*4 | | 206-0303-00*4 | | 206-0336-03*2*4 | |
| | 2 | 206-0318-02*4 | | 175-9409-00*4 | | 206-0304-00*4 | | 206-0337-01*2*4 | |
| | 3 | 206-0333-00*4 | | 175-9410-00*4 | | 206-0305-00*4 | | 206-0338-01*2*4 | |
| P6121 | 1.5 | 206-0311-00 | $50.00 | 175-9411-00 | $19.00 | 206-0323-00 | $20.00 | 206-0341-01*2 | $25.00 |
| P6122 | 1.5 | 206-0312-00 | $50.00 | 175-9411-00 | $19.00 | 206-0324-00 | $20.00 | 206-0342-01*2 | $25.00 |
| | 2 | 206-0318-00 | $50.00 | 175-9412-00 | $23.00 | 206-0325-00 | $20.00 | 206-0343-01*2 | $25.00 |
| | 3 | 206-0318-01 | $50.00 | 175-9413-00 | $27.00 | 206-0326-00 | $20.00 | 206-0344-01*2 | $25.00 |
| P6125 | 1.5 | 206-0335-00*4 | | 175-9411-00 | $19.00 | 206-0256-02*4 | | 206-0191-03*1 | $17.00 |
| P6130 | 1.5 | 206-0313-00 | $80.00 | 175-9415-00 | $19.00 | 206-0270-00 | $12.00 | 206-0270-00*3 | $12.00 |
| | 2 | 206-0319-00 | $80.00 | 175-9416-00 | $23.00 | 206-0270-02 | $12.00 | 206-0270-02*3 | $12.00 |
| | 3 | 206-0320-00 | $80.00 | 175-9417-00 | $27.00 | 206-0270-01 | $12.00 | 206-0270-01*3 | $12.00 |
| P6131 | 1.3 | 206-0314-00 | $80.00 | 175-9414-00 | $19.00 | 206-0265-00 | $12.00 | 206-0265-00*3 | $12.00 |
| | 2 | 206-0312-00 | $50.00 | 175-9416-00 | $23.00 | 206-0265-02 | $12.00 | 206-0265-02*3 | $12.00 |
| | 3 | 206-0322-00 | $80.00 | 175-9417-00 | $27.00 | 206-0265-01 | $12.00 | 206-0265-01*3 | $12.00 |
| P6148 | 2 | 206-0288-00 | $45.00 | 175-1661-00 | $27.00 | 206-0234-00 | $38.00 | 206-0191-03*1 | $17.00 |
| P6148A | 2 | 206-0288-02*4 | | 175-9409-00*4 | | 206-0217-02 | $48.00 | 206-0339-01*2*4 | |
| P6149 | 2 | 206-0255-00 | $40.00 | 175-1661-01 | $27.00 | 206-0234-00 | $38.00 | 206-0191-03*1 | $17.00 |
| P6149A | 2 | 206-0255-02*4 | | 175-9409-00*4 | | 206-0217-02 | $48.00 | 206-0339-01*2*4 | |

*1 Probe tips in packages of ten.
*2 Probe hybrid tip assemblies in packages of five.
*3 probe hybrid tip assembly in quantities of one.
*4 Contact your local sales engineer for information.

**To order, call your local Tektronix Field Office, or call Tek's National marketing Center, toll free: 1-800-426-2300, Ext 99. In Oregon call collect (503) 627-9000, Ext 99.**

## *IMPROVED*

**P6101A**
**Dc to 34 MHz 1X**

**P6106A** Dc to 250 MHz
**10X with Readout**

**P6105A** Dc to 100 MHz
**10X with Readout**

**P6108A** Dc to 100 MHz
**10X**

**P6107A** Dc to 100 MHz
**10X with Readout**

**P6149A** Dc to 50 MHz
**10X**

**Simplified, Faster Maintenance and Repairs**

**High Fidelity Signal Acquisition at Low Cost**

**Rugged for Greater Reliability**

**Available in Three Lengths**

Modular probes are an exciting new concept in probe design. The P6101, P6105A, P6106A, P6107A, P6108A, and P6149A probes divide into three modules (probe heads, cables, and connector/compensation boxes). The modules snap together making maintenance and repair less expensive, faster, and much easier. Snap-on replacement modules eliminate soldering irons and tools, and modular probes do not have to be sent in to be repaired because spare modules can be ordered and stocked. Strain relief and modular component design make these probes rugged for greater reliability.

The P6101, P6105A, P6106A, and P6108A are available in three color-coded lengths—blue for one meter, yellow for two meters, and red for three meters. (The P6149A and P6107A are two meters long.) These probes may be used to acquire high fidelity signal from low source-impedance circuits.

Tektronix modular probes are designed for specific Tektronix instruments, but may be purchased as options for all Tektronix oscilloscopes with 1 MΩ and appropriate pF inputs as indicated in the chart.

With oscilloscopes that are equipped with vertical scale or CRT readout, the P6105A and P6106A will automatically scale the readout by a factor of ten.

The P6149A and P6107A feature a right angle BNC connector. This can be useful when bench space is limited.

For electrical characteristics refer to the table on page 449.

### CHARACTERISTICS

#### ENVIRONMENTAL CHARACTERISTICS

**Temperature** — Operating: −15°C to +75°C (+5°F to +167°F). Nonoperating: −62°C to +85°C (−80°F to +185°F).

**Altitude** — Operating: 4600 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

**Humidity** — Operating and Nonoperating: Five cycles (120 hrs) at 95% to 97% relative humidity.

#### INCLUDED ACCESSORIES

Retractable hook tip (BB, 013-0107-03); insulating sleeve (BP, 166-0404-01); two probe tips, available in packages of 10 only (BO, 206-0191-03); probe holder (352-0351-00); 75 mm ground lead for P6106 only (DD, 175-0263-01); 130 mm ground lead for P6101, P6105, P6108 and P6149 only (DD, 175-0124-01) 300 mm ground lead (DD, 175-0125-01); three pair, black, white and silver gray marker bands for all probes except P6149, available in packages of nine sets of different colors (016-0633-00); two pair, gray and silver gray marker bands for P6149, available in packages of nine sets of different color (016-0633-00); two miniature alligator clips (AS, 344-0046-00); accessory pouch (016-0521-00); instruction manual.

### ORDERING INFORMATION

**P6101A** 1X Probe, 2 m Cable. Order 010-6101-03 ..... **$67**
**Option 01** — 1 m cable. Order 010-6101-11 ..... **$67**
**Option 02** — 3 m cable. Order 010-6101-15 ..... **$67**

**P6105A** 10X Probe, 2 m Cable. Order 010-6105-13 ..... **$110**
**Option 01** — 1 m cable. Order 010-6105-11 ..... **$110**
**Option 02** — 3 m cable. Order 010-6105-15 ..... **$110**

**P6106A** 10X Probe, 2 m Cable. Order 010-6106-13 ..... **$140**
**Option 01** — 1 m cable. Order 010-6106-11 ..... **$140**
**Option 02** — 3 m cable. Order 010-6106-15 ..... **$140**

**P6107A** 10X Probe, 2 m Cable. Order 010-6107-13 ..... **$117**

**P6108A** 10X Probe, 2 m Cable. Order 010-6108-13 ..... **$100**
**Option 01** — 1 m cable. Order 010-6108-11 ..... **$100**
**Option 02** — 3 m cable. Order 010-6108-15 ..... **$100**

**P6149A** 10X Probe, 2 m cable. Order 010-6149-13 ..... **$110**

## P6121 Dc to 100 MHz 10X with Readout
## P6122 Dc to 100 MHz 10X

**Lightweight Tip**

**Flex Lightweight Cable**

**100 MHz Bandwidth**

**UL Listed**

The P6121 and P6122 probes are miniature, 10X passive probes and are fully compatible with the Tektronix family of miniature probe accessories. The P6121 with readout capability is designed specifically for use with the Tektronix 2236 portable oscilloscope. The P6122 general purpose probe accommodates oscilloscopes with bandwidths up to 100 MHz. Both probes feature modular, easily replaceable parts, easy to use configuration, and hybrid circuitry. The hybrid probe tip circuitry proves more uniform probe tip compensation for better high frequency response with reduced aberration and also extremely good environmental characteristics (see Electrical Characteristics table).

### CHARACTERISTICS

#### ENVIRONMENTAL

**Temperature Range** — Operating: −15°C to +75°C. Nonoperating: −62°C to +85°C.

**Humidity** — Five cycles (120 hr) 95% to 97% at +30°C to +60°C. MIL-E-16400F, Class 4.

**Altitude** — Operating: 4600 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

#### ELECTRICAL CHARACTERISTICS

| | Probe Length | P6121 | P6122 |
|---|---|---|---|
| **Attenuation** | | 10X ±0.2% | 10X ±3% |
| **Loading** | 1.5 m | 11 pF/10 MΩ | 11 pF/10 MΩ |
| **Bandwidth** | 1.5 m | 100 MHz | 100 MHz |
| **Dc Max** | | 500 V | 500 V |
| **Scope Compatibility** | | Designed to be used only with the Tektronix 2236. (1 MΩ input) | May be used with any Tektronix 100 MHz, 1 MΩ, 15 to 35 pF scope or plug-in*[1]. |

*[1] *Typical applications include the Tektronix T935A, T922R, T921, 2213, 2215, 2235, 2335, 2336, 2337, 5A38, 5A48, 7A15A, and the 7A18A.*

#### INCLUDED ACCESSORIES

Protective pouch (016-0708-00); retractable hook tip (013-0107-04); ground cover sleeve (166-0404-01); alligator ground lead (195-1870-00); IC test tip (015-0201-03); bayonet ground lead (195-6176-00); gray marker band (334-2794-02); miniature alligator clip (344-0046-00); instruction manual.

### ORDERING INFORMATION

**P6121** 10X, 1.5 m Probe. Order 010-6121-01 ..... **$100**

**P6122** 10X, 1.5 m Probe. Order 010-6122-01 ..... **$77**

**P6122** 10X, 2 m Probe. Order 010-6122-03 ..... **$77**

**P6122** 10X, 3 m Probe. Order 010-6122-05 ..... **$77**

#### OPTIONAL ACCESSORIES

**Electrical Lead** — 23 AWG, 6.3 L. Order 195-4104-00 ..... **$7.00**

**Probe Tip with Actuator** — Order 013-0191-00 ..... **$6.50**

**IC Probe Tip** — Package of 10. Order 015-0201-04 .... **$7.00**

**IC Probe Tip** — Package of 100. Order 015-0201-05 **$18.00**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## P6130 Dc to 250 MHz 10X with Readout
## P6131 Dc to 300 MHz 10X with Readout

**Lightweight Tip**

**Flex Lightweight Cable**

**250 MHz Bandwidth**

**UL Listed**

The P6130 and P6131 are 10X subminiature passive probes. Both probes have a spring-loaded coding pin on the BNC output connector which activates the volts/division readout-encoding circuit of the oscilloscope to include the 10X attenuation of the probe.

The P6130 general purpose probe accommodates scopes with bandwidths up to 250 MHz. Choose 1.5 meter, 2 meter, or 3 meter lengths. *The P6131 is specifically designed to be used only with the Tektronix 2465/2445 and the 7A42.* 1.3 meter and 3 meter lengths are available.

Both probes feature small size, a low-mass probe tip, and an extremely flexible probe cable. The unique reversible ground lead system provides versatile grounding methods. The hybrid probe tip circuitry provides a rugged lightweight tip, more uniform probe tip compensation for better high frequency response with reduced aberrations, and extremely good environmental characteristics. The modular construction of the probes allows easy repair without tools for lower cost of ownership.

A subminiature-to-miniature probe tip adaptor (013-0202-00) is also available. This adaptor allows the subminiature probe family to use the wide variety of probe accessories that Tektronix already provides for its miniature probe product line.

**ELECTRICAL CHARACTERISTICS**

| | Probe Length | P6130 | P6131 |
|---|---|---|---|
| **Attenuation** | | 10X ±3% | 10X ±1% |
| **Loading** | 1.3 m | — | 10.8 pF/10 MΩ |
| | 1.5 m | 12.7 pF/10 MΩ | — |
| | 2.0 m | 13.2 pF/10 MΩ | — |
| | 3.0 m | 14.5 pF/10 MΩ | 14.5 pF/10 MΩ |
| **Bandwidth** | 1.3 m | — | 300 MHz |
| | 1.5 m | 250 MHz | — |
| | 2.0 m | 250 MHz | — |
| | 3.0 m | 150 MHz | 150 MHz |
| **Dc Max** | | 500 V | 500 V |
| **Scope Compatibility** | | May be used with Tektronix 2235, 2236, 464, 465, 466, 475, 485, and any 7000 Series 1 MΩ plug-in such as 7A15, 7A16, 7A18, and 7A26. | Designed to be used with the Tektronix 2465, 2445, and the 7A42. (1 MΩ input) |

## CHARACTERISTICS

### ENVIRONMENTAL

**Temperature Range** — Operating: −15°C to +75°C. Nonoperating: −62°C to +85°C.

**Humidity** — Five cycles (120 hr) 95% to 97% at +30°C to +60°C. MIL-E-16400F, Class 4.

**Altitude** — Operating: 4600 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

### INCLUDED ACCESSORIES

Alligator ground lead (195-1870-01), microhook ground lead (195-4104-01); low inductance ground lead (195-4240-00); white marker band (334-2794-01; gray marker band (334-2794-03); red marker band (334-2794-06); green marker band (334-2794-07); probe connector (131-2766-03); probe holder (352-0687-00); protective pouch (016-0708-00); retractable hook tip (013-0208-00); instruction manual.

## ORDERING INFORMATION

**P6130** 10X, 1.5 m Probe. Order 010-6130-01 ..... **$130**

**P6130** 10X, 2 m Probe. Order 010-6130-03 ..... **$130**

**P6130** 10X, 3 m Probe. Order 010-6130-05 ..... **$130**

**P6131** 10X, 1.3 m Probe. Order 010-6131-01 ..... **$140**

**P6131** 10X, 2 m Probe. Order 010-6131-03 ..... **$140**

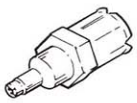
**P6131** 10X, 3 m Probe. Order 010-6131-05 ..... **$140**

*P6130 shown with 013-0202-00 adaptor in place.*

### SUBMINIATURE PROBE ACCESSORIES

**PROBE-TO-BNC**
**013-0195-00**

**PROBE-TO-GR**
**017-0520-00**



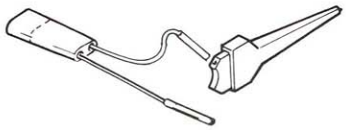
**TEST POINT**
**131-2766-01**
**136-0352-02**

**SUBMINIATURE-TO-MINIATURE**
**013-0202-00**

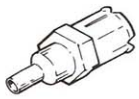
### MINIATURE PROBE ACCESSORIES

**MINIATURE PROBE TIP TO DUAL LEAD ADAPTOR**
**013-0084-01**

**MINIATURE RETRACTABLE HOOK TIP**
**206-0222-00**



**PROBE-TO-GR**
**017-0088-00**



**PROBE TO BNC**
**013-0084-01**

**BAYONET**
**013-0085-00**

**Probe to BNC Adaptor** — Order 013-0195-00 ..... **$9.00**
**50 Ω Probe to GR Adaptor** — Order 017-0520-00 ..... **$48**
**100 ECB Test Points** — Outer Shell. Order 131-2766-01 ..... **$22**
**100 Probe ECB Test Connectors** — Center. Order 136-0352-02 ..... **$.30**
**Subminiature-to-Miniature Adaptor** — Order 013-0202-00 ..... **$4.00**

### The following are used with the subminiature-to-miniature adaptor.

**Miniature-to-BNC Adaptor** — Order 013-0084-01 ..... **$8.00**
**Miniature Bayonet Tip Adaptor** — Order 013-0085-00 . **$8.50**
**50 Ω Miniature-to-GR Adaptor** — Order 017-0088-00 ... **$50**
**Miniature-to-Squarepin Adaptor** — Order 015-0325-00 ..... **$15**
**Microcircuit Pincer Tip** — Order 206-0222-00 ..... **$3.50**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## P6015 40 kV 1000X

**Measure up to 40 kV Peak Pulse**

**High Voltage Probe**

**Up to 20 kV Dc + Peak Ac**

**75 MHz Useful Bandwidth**

**For 1 MΩ Inputs**

The P6015 Provides 1000X attenuation for oscilloscope measurements up to 40 kV peak. Voltage or duty cycle derating is necessary for RF voltages at frequencies over 100 kHz, or in temperatures above 25°C.

The probe can be compensated for instruments with nominal input capacitance of 12 pF to 47 pF and input resistance of 1 MΩ.

**INCLUDED ACCESSORIES**

BNC compensating box (015-0049-00); high-voltage dielectric fluid can (AU, 252-0120-00); alligator clip (AQ, 344-0005-00); carrying case (016-0128-02); probe holder (352-0056-00); instruction manual.

**ORDERING INFORMATION**

**P6015** 1000X, 10 ft, High Voltage Probe. Order 010-0172-00 ..... **$650**

## P6007 Dc to 25 MHz 100X

**1500 V Dc**

**Low Capacitance Loading**

The P6007 is a low input capacitance, high-voltage (1.5 kV) probe. It can be compensated to match all Tektronix plug-ins and oscilloscopes with nominal input capacitances of 15 pF to 55 pF and input resistance of 1 MΩ.

**INCLUDED ACCESSORIES**

Banana tip (AK, 134-0013-00); 0.055 inch diameter straight tip (AA, 206-0015-00); retractable hook tip (AN, 013-0071-00); 13 cm (5 inch) ground lead (175-0124-01); 30 cm (12 inch) ground lead (175-0125-01); hook tip (AG, 206-0105-00); probe holder (352-0090-00); two alligator clips (AS, 344-0046-00); instruction manual.

**ORDERING INFORMATION**

**P6007** 100X, High Voltage Probe.

6 ft Cable. Order 010-0165-00 ..... **$110**

3.5 ft Cable. Order 010-0150-00 ..... **$110**

9 ft Cable. Order 010-0152-00 ..... **$110**

12 ft Cable. Order 010-0154-00 ..... **$110**

## P6009 Dc to 120 MHz 100X

**1500 V Dc**

**Dc to 120 MHz**

**Low Capacitance—2.5 pF**

The P6009 is a low input capacitance, high-voltage (1.5 kV) probe designed for use with Tektronix dc to 150 MHz oscilloscopes. The probe can be compensated to match Tektronix plug-ins and oscilloscopes with nominal input capacitances of 12 pF to 47 pF and input resistance of 1 MΩ.

A version of the P6009 is equipped with a special BNC connector that provides CRT Readout information when used with plug-in units and mainframes that have these features.

**INCLUDED ACCESSORIES**

30 cm (12 inch) ground lead (175-0125-01); 13 cm (5 inch) ground lead (175-0124-01); 7.5 cm (3 inch) ground lead (DD,175-0263-01); probe holder (352-0090-00); 0.080 inch diameter spring tip (AB, 206-0060-00); two alligator clips (AS, 344-0046-00); banana tip (AK, 134-0013-00); 0.055 inch diameter straight tip (AA, 206-0015-00); retractable hook tip (AN, 013-0071-00); hook tip (AG, 206-0105-00); bayonet ground assembly (AJ, 013-0052-00); instruction manual.

**ORDERING INFORMATION**

**P6009** 100X, 9 ft, High Voltage Probe W/Readout. Order 010-0264-01 ..... **$175**

W/O Readout. Order 010-0170-00 ..... **$175**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## CHARACTERISTICS

| | Attenuation | Accuracy | Input Resistance | Input Capacitance 3½ ft | 6 ft | 9 ft | Probe Risetime | Aberrations | Bandwidth | Nominal Cable Length (ft) | Maximum Dc Voltage | Derated Above | Derated to @ Frequency | Compensation Range (pF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P6007 | 100X | 3% | 10 MΩ | 2 pF | 2.2 pF | 2.4 pF | 14.0 ns | ±3 | 25 MHz | 3½, 6, 9, 12 | 1.5 kV | 200 kHz | 2 kV @ 5 MHz | 15 to 55 |
| P6009 | 100X | 3% | 10 MΩ | | 2.5 pF | | 2.9 ns | ±3 | 120 MHz | 9 | 1.5 kV | 200 kHz | 300 V @ 20 MHz | 15 to 47 |
| P6015 | 1000X | Adjustable | 100 MΩ | 3 pF (10 ft only) | | | 4.0 ns | ±5 | 75 MHz | 10 | 20.0 kV | 100 kHz | 2 kV @ 20 MHz | 12 to 47 |

**Included Accessories with double alpha codes are pictured on pages 456 and 457**

## P6062B Dc to 100 MHz with Readout
## P6063B Dc to 200 MHz with Readout

### 1X to 10X Selectable Attenuation

### Switch on Probe Body

The P6062B and P6063B are passive dual attenuation probes designed for Tektronix oscilloscopes with bandwidths to 100 and 200 MHz. A sliding switch on the probe body selects 1X or 10X attenuation. The probe provides readout coding and a pushbutton for actuating a ground reference in the 1X or 10X position. The ground reference can be used as a means of trace identification for a multitrace display. The 1X position of the probe allows the use of the full instrument sensitivity. This is valuable when evaluating small signals of 10 MHz or less. The 1X-10X switch allows the user to switch in and out a decade of sensitivity without returning to the oscilloscope. The user may also arbitrarily switch from 1X to 10X in order to evaluate the effects of loading by the oscilloscope.

The P6063B is a fast-rise dual attenuation, passive probe designed for Tektronix oscilloscopes with bandwidths greater than 100 MHz.

**COMMON CHARACTERISTICS**

| | Nominal Probe Length | P6062B | | P6063B | |
|---|---|---|---|---|---|
| Attenuation | | 1X | 10X | 1X | 10X |
| Accuracy | | Same as Scope | 3%*1 | Same as Scope | 3%*1 |
| Input Resistance | | Same as Scope | 10 MΩ*1 | Same as Scope | 10 MΩ*1 |
| Input Capacitance | 3½ ft<br>6 ft<br>9 ft | 100 pF<br>105 pF<br>135 pF | 13.5 pF<br>14 pF<br>17 pF | 80 pF<br>105 pF<br>NA | 11 pF<br>14 pF<br>NA |
| Bandwidth | 3½ ft<br>6 ft<br>9 ft | 8 MHz<br>6.7 MHz<br>4.5 MHz | 100 MHz<br>100 MHz<br>100 MHz | 12 MHz<br>6 MHz<br>NA | 200 MHz<br>200 MHz<br>NA |
| Maximum Voltage | | 100 V peak | 500 V peak | 100 V | 500 V |
| Derated Above | | 450 kHz | 3.5 MHz | 450 kHz | 4.5 MHz |
| Derated to Frequency | | 35 V @ 10 MHz | 35 V @ 50 MHz | 35 V @ 10 MHz | 30 V @ 50 MHz |
| Aberrations | | ±3% | <5% p-p | ±3% | <5% p-p |
| Risetime | | | 3.5 ns | | 1.7 ns |
| Compensation Range | | 15 pF to 47 pF | | 15 pF to 24 pF | |

*1 *In 10X position the input R = 10 MΩ ±0.5% with an oscilloscope input R = 1 MΩ ±2%.*

## P6053B 10X with Readout

### Miniature

### Fast Risetime

The P6053B is a miniature fast-rise 10X probe designed for Tektronix instruments having a nominal input capacitance of 15 pF to 24 pF. The probe has a pushbutton for actuating the trace-identify function of the oscilloscope mainframe and readout capability.

**CHARACTERISTICS**

**Attenuation** — 10X. **Input Resistance** — 10 MΩ. **Input Capacitance** — 9.5 pF with 3.5 ft probe. 12.5 pF with 6 ft version, 13.5 pF with 9 ft version. **Bandwidth (with 225 MHz or Greater Oscilloscope)** — ≈200 MHz for 3.5 and 6 ft versions, ≈115 MHz for the 9 ft version. **Voltage Rating** — 500 V (dc + peak ac). Peak voltage derating is necessary for cw frequencies higher than 5 MHz. At 10 MHz, the maximum allowable peak voltage is 275 V; 23 V at 100 MHz; 18 V at 150 MHz.

**INCLUDED ACCESSORIES**

Probe holder (352-0351-00); electrical insulating sleeve (BP, 166-0404-01); retractable hook tip (BB, 013-0107-03); probe tip hook (BU, 206-0114-00); accessory pouch (016-0521-00); 13 cm (5 inch) ground lead (175-0124-01); 30 cm (12 inch) ground lead (DD, 175-0125-01); two alligator clips (AS, 344-0046-00). For P6053B only, bayonet ground assembly (BM, 013-0085-00); 7.5 cm (3 inch) ground lead (DD, 175-0263-01); instruction manual.

**ORDERING INFORMATION**

**P6062B** Switchable Attenuation Probe.
6 ft Cable. Order 010-6062-13 ..... **$175**
3.5 ft Cable. Order 010-6062-11 ..... **$175**
9 ft Cable. Order 010-6062-15 ..... **$175**

**P6063B** Switchable Attenuation Probe.
6 ft Cable. Order 010-6063-13 ..... **$215**
3.5 ft Cable. Order 010-6063-11 ..... **$215**

**P6053B** Miniature 10X Probe.
6 ft Cable. Order 010-6053-13 ..... **$170**
3.5 ft Cable. Order 010-6053-11 ..... **$170**
9 ft Cable. Order 010-6053-15 ..... **$170**

## P6055 20,000:1 CMRR 10X with Readout

### High CMRR

### Compact Size

### Low Capacitance

### Dc to 60 MHz

The P6055 is a miniature, low-capacitance, 10X probe designed for use with Tektronix differential amplifiers with nominal input capacitances from 20 pF to 47 pF. The attenuation ratio is adjustable to compensate for differences in input resistance of the amplifier (the amplifier input resistance must be 1 MΩ ± 2%). A special locking type readout connector allows the probe to be used with instruments with or without readout capability.

When two P6055 Probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other is helpful in maintaining the CMRR of the system. The use of a matched pair of P6055 differential probes provide the best possible system CMRR.

**CHARACTERISTICS**

**CMRR** — 20,000:1 from dc to 1 kHz derating to 100:1 at 20 MHz. **Attenuation** — Adjustable to 10X. **Input Resistance** — 1 MΩ ±0.5%. **Input Capacitance** — ≈10 pF when used with instrument that has 20 pF input capacitance; 12.5 pF when used with instrument that has 47 pF input capacitance. **Maximum Useful Bandwidth** — 60 MHz. **Typical Probe Risetime** — 5.8 ns. **Maximum Voltage** — 500 V (dc + peak ac) from dc to 12 MHz. P-p voltage derates to 100 V at 70 MHz.

**INCLUDED ACCESSORIES**

Retractable hook tip (BB, 013-0107-03); 13 cm (5 inch) ground lead (175-0124-01); probe holder (352-0090-00); two electrical insulating sleeves (BP, 166-0404-01); two alligator clips (AS, 344-0046-00); adjustable tool (CP, 003-0675-01); hook tip (BU, 206-0114-00); 13 cm (6 inch) electrical ground lead (DF, 175-1256-00); 30 cm (12 inch) ground lead (175-0125-01); instruction manual.

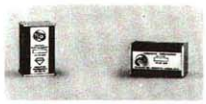
**ORDERING INFORMATION**

**P6055** 10X, 3.5 ft Differential Probe, Order 010-6055-01 ..... **$275**
Matched Pair of Two P6055 Probes. Order 015-0437-00 ..... **$485**

**See page 456 for probe accessories.**

**To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

## MECHANICAL MEASUREMENT TRANSDUCERS

| Transducer Package | Description | Performance | Recommended Accessories |
|---|---|---|---|
| PRESSURE 015-0161-00*1 | Range: 3000 psig<br>Type: Bonded Strain Gage<br>4 arm 350 Ω bridge<br>Built-in CAL resistor | Accuracy: 1%<br>Excitation: ≈10 V dc<br>Scale Factor: 3 mV/V fs<br>fn ≈65 kHz | 012-0209-00<br>20 ft multiconductor cable |
| PRESSURE 015-0162-00*1 | Range: 300 psig<br>Type: Bonded Strain Gage<br>4 arm 350 Ω Bridge<br>Built-in CAL resistor | Accuracy: 1%<br>Excitation: ≈10 V dc<br>Scale Factor: 3 mV/V fs<br>fn ≈24 kHz | 012-0209-00<br>20 ft multiconductor cable |
| PRESSURE (EAS) 015-0117-00 | Range: 3000 psig (dynamic only)<br>Type: Plezoelectric | Accuracy: <5%<br>Sensitivity: 200 pc/psi<br>Max Overpressure: 300%<br>Temp: −40°C to +150°C max | 015-0118-00<br>cooling adaptor |
| ACCELERATION 015-0165-00 | Range: 0.001 to 1000 g's<br>Type: Piezoelectric compression<br>High capacitance (≈10,000 pF)<br>NBS traceability | Accuracy: 5%<br>Linearity: 2%<br>Sensitivity: ≈12 mV/g<br>fn ≈30 kHz | 012-0211-00<br>microdot to BNC<br>20 ft cable |
| VIBRATION (EAS) 015-0116-00 | Range: 0.01 to 100 g's (100 to 10,000 RPM)<br>Type: Piezoelectric<br>magnetically mounted<br>fn ≈11 kHz | Sensitivity: 6 mV/g (oc)<br>Cr ≈3500 pF<br>Temp: −40°C to +150°C | 012-0137-00<br>BNC-BNC cable<br>50 ft |
|  VERTICAL VIBRATION 015-0166-00<br>HORIZONTAL VIBRATION 015-0167-00 | Type: Seismic (geophone)<br>Self-generating<br>Signals: Velocity Displacement<br>(integrated velocity)<br>Range: 0.050 in p-p | Accuracy: <5%<br>Scale Factor:<br>Velocity ≈600 mV/in/s<br>Displacement ≈10 mV/0.001 in<br>Freq Range: 10 Hz to 2 kHz<br>fn ≈8 Hz<br>Temp: −40°C to +71°C | 012-0136-00<br>BNC-BNC cable<br>20 ft long |
| FORCE (Displacement) 015-0164-00*1 | Range: 50 grams<br>50 lbs (with load cell) 0.120 mm<br>Type: Unbonded 350 Ω Strain Gage<br>4 arm bridge | Accuracy: 0.5%<br>Excitation: ≈5 V dc<br>Full Scale Output: 60 to 80 mV<br>Temp: −50°C to +85°C and tools | Included with unit is<br>50 lb (22 to 5 kg) load<br>cell connected, power<br>cable attachment bracket |
| DISPLACEMENT 015-0168-00 | Range: ±4.0 mm (Calibrated<br>& usable to ±0.2 in)<br>Type: Dc to dc LVDT | Accuracy: 2% linearity <1%<br>Excitation: 3 to 11 V dc<br>Scale Factor: 1 V/mm at 8.5 V dc<br>20 mV/0.001 inch at 7.5 V dc<br>Temp: −54°C to +60°C | 012-0209-00<br>20 ft cable |
| STRAIN 015-0171-00 | Range: 30,000 μ Strain<br>Type: Foil Strain Gage 0.125 in long.<br>Attached leads<br>Package of five | Resistance: 120 Ω<br>Gage Factor (nominal) 2.1<br>Accuracy: 1%<br>Excitation: (bridge), 5 V max | Strain Gage Adaptor<br>015-0169-00<br>Cement Kit<br>015-0172-00 |
| STRAIN GAGE ADAPTOR 015-0169-00*1 | Provides means for connecting 1, 2, or 4 arms of a Wheatstone Bridge to the Type PS 501-1 Mod 730E Transducer Power Supply. Has variable shunt resistor for gage factor calibration. The adaptor has 4 binding post terminals and a 6-foot cable with 6-pin connector. | Accuracy: Governed by initial calibration and strain gages used.<br>Strain Gage Resistance Range:<br>30 Ω to 5000 Ω for 4 arm bridges.<br>120 Ω for 1, 2 or 4 arm bridges.<br>Bridge Volts: Typically 5 V for 120 Ω gages.<br>Gage Factor Correction Range: 1.7 to 2.3 | Strain Gage Package<br>015-0171-00<br>Cement Kit<br>015-0172-00 |
| CEMENT KIT 015-0172-00 | Provides means for mounting and connecting foil strain gages. Includes Room Temperature Curing Epoxy cement, RTV Clear Silicon Rubber coating. Neoprene pads and metal plates cementable Wiring terminals, and clear Mylar film. | | Strain Gage Package<br>015-0171-00 |

**1 Requires PS 501-1 custom modified Transducer Power Supply mounted in a TM 500 Series mainframe. Consult a Tektronix Sales Engineer for price and installation information on power supply and adaptor.*

**Cable** — 20 ft low-noise cable with BNC connectors on both ends. Order 012-0136-00 ..... **$75**

**Cable** — 20 ft low-noise 6-conductor cable with 6-pin connector on each end. Order 012-0209-00 ..... **$315**

**Cable** — 20 ft 6-conductor cable with 6-pin male connector on 1 end. Order 012-0210-00 ..... **$115**

**Cable** — 20 ft low-noise coaxial cable with minature coaxial connector on 1 end and BNC connector on the other. Order 012-0211-00 ..... **$50**

**Cable** — 50 ft low-noise cable with BNC connectors on both ends. Order 012-0137-00 ..... **$90**

**Connector** — Mates Type PS 501-1 Transducer Power Supply Input 6-pin connector. Order 131-0618-00 ..... **$44**

**Cooling Adaptor** — For use with 015-0117-00 Pressure Transducer to keep body temperature at or below +150°C. Also reduces effects of preignition explosions. Order 015-0118-00 ..... **$600**

### TRANSDUCER PACKAGE PRICE LIST

| | | | |
|---|---|---|---|
| 015-0161-00 | $825 | 015-0167-00 | $525 |
| 015-0162-00 | $695 | 015-0164-00 | $915 |
| 015-0117-00 | $1,625 | 015-0168-00 | $645 |
| 015-0165-00 | $510 | 015-0169-00 | $500 |
| 015-0116-00 | $1,100 | 015-0171-00 | $42 |
| 015-0166-00 | $265 | 015-0172-00 | $120 |

**See next page for probe accessories**

## #6-32 Probe Tips and Accessories

The following tips and adaptors can be used on all Tektronix Probes that accept a #6-32 screw-on tip, including the P6006, P6007, P6008, P6009, P6028, and P6060 Probes and others with 6-32 adaptor.

| CODE | DESCRIPTION | PART NUMBER | PRICE |
|---|---|---|---|
| AA | Probe straight tip (0.055 in dia) | 206-0015-00 | $1.25 |
| AB | Probe spring tip (0.080 in dia) | 206-0060-00 | $2.00 |
| AC | Probe spring tip (accepts 0.065 in dia pin) | 206-0061-00 | $1.50 |
| AD | Probe spring tip (accepts 0.068 in dia pin) | 206-0168-00 | $3.00 |
| AE | IC test tip | 206-0203-00 | $1.50 |
| AF | Probe long straight tip (0.032 in dia) | 206-0104-00 | $1.15 |
| AG | Probe hook tip | 206-0105-00 | $1.15 |
| AH | Probe ground lead adaptor (#6-32 to 0.025 in square pin closing) | 206-0137-01 | $2.50 |
| AI | Probe right angle hook tip | 206-0185-00 | $1.50 |
| AJ | Bayonet ground assembly | 013-0052-00 | $8.50 |
| AK | Probe banana tip | 134-0013-00 | $1.00 |
| AL | Probe ground cover (for P6009) | 166-0428-00 | $1.35 |
| AM | Probe calibration tip (0.063 in dia) | 206-0100-00 | $10.50 |
| AN | Probe retractable hook tip | 013-0071-00 | $3.50 |
| AP | Probe retractable hook tip (for P6008E) | 013-0071-01 | $3.00 |
| AQ | Alligator clip | 344-0005-00 | $4.00 |
| AR | Alligator clip | 344-0045-00 | $0.80 |
| AS | Minature alligator clip | 344-0046-00 | $2.15 |
| AT | Probe tip to BNC adaptor | 013-0054-00 | $15.00 |
| AU | High-voltage dielectric fluid 3 oz | 252-0120-00 | $5.00 |
| AV | Probe pin tip (accepts 0.025 in IBM SLT in) | 206-0134-03 | $4.50 |
| AW | Probe tip to BNC adaptor (for P6028) | 013-0056-00 | $15.00 |

### MODULAR/MINIATURE ADAPTORS

| CODE | DESCRIPTION | PART NUMBER | PRICE |
|---|---|---|---|
| BA | Retractable hook tip (for all miniature probes) | 013-0105-00 | $8.50 |
| BB | Retractable hook tip (for P6053B, P6055, P6062B, P6063B, P6101, P6105, P6106, P6108, and P6149) | 013-0107-03 | $3.25 |
| | Retractable hook tip (for P6120, P6121, and P6122) | 013-0107-04 | $2.20 |
| BC | Probe tip, IC Grabber | 013-0191-00 | $6.50 |
| BD | Miniature retractable hook tip | 206-0222-00 | $3.50 |
| BE | Probe tip flexible, adapts miniature probe to retractable hook tip (BD) | 103-0177-01 | $6.50 |
| BF | Probe tip flexible for 0.025 square pin | 206-0193-00 | $8.00 |
| BG | Miniature probe to #6-32 adaptor (for all miniature probes except P6045 and P6202) | 103-0051-01 | $4.00 |
| BH | Miniature probe to #6-32 adaptor with ground connection | 103-0131-00 | $6.50 |
| BI | Probe pin tip (accepts 0.025 in IBM SLT pin) | 206-0209-00 | $3.50 |
| BJ | Miniature probe tip to GR adaptor | 017-0076-00 | $55.00 |
| BK | Miniature probe tip to GR 50 Ω termination adaptor | 017-0088-00 | $50.00 |
| | Subminiature probe tip to GR 50 Ω termination adaptor | 017-0520-00 | $48.00 |
| BL | Chassis mount test jack (for miniature probes) | 131-0258-00 | $4.50 |
| BM | Bayonet ground assembly | 013-0085-00 | $8.50 |
| BN | Miniature probe tip cover, IC tester, Package of 10 | 015-0201-04 | $7.00 |
| | Package of 100 | 015-0201-05 | $18.00 |
| BO | Replaceable probe tip, pkg of 10. All miniature probes except P6202 and P6420 | 206-0191-03 | $17.00 |
| BP | Miniature probe tip ground cover, insulating sleeve | 166-0404-01 | $1.00 |
| BQ | Electrical contact | 214-0283-00 | $1.00 |
| BR | Termination, 50 Ω | 011-0049-01 | $25.00 |
| BS | Miniature probe tip to BNC adaptor | 013-0084-01 | $8.00 |
| | Subminiature probe tip to BNC adaptor | 013-0195-00 | $9.00 |
| BT | Miniature probe tip to BNC adaptor for all except P6202 | 013-0084-02 | $10.00 |
| BU | Miniature probe tip hook | 206-0114-00 | $2.95 |
| BV | Miniature probe tip straight | 206-0114-01 | $2.95 |
| BW | Miniature probe tip to dual lead adaptor | 015-0325-00 | $15.00 |
| BX | Subminiature retractable hook tip | 013-0208-00 | $1.75 |
| BY | Subminiature to miniature probe tip adaptor (allows use of minature accessories with subminiature probes) | 013-0202-00 | $4.00 |
| BZ | Circuit board probe test point outer case | 131-1436-00 | $24.00 |
| | Circuit board probe test point inner connector (need to order both for one test point) | 136-0333-00 | $0.50 |
| BAA | Miniature probe tip to BNC female | 103-0096-00 | $11.00 |

**To order, call direct to your local Central Parts Ordering desk. See page 12 for the toll-free number for your area.**

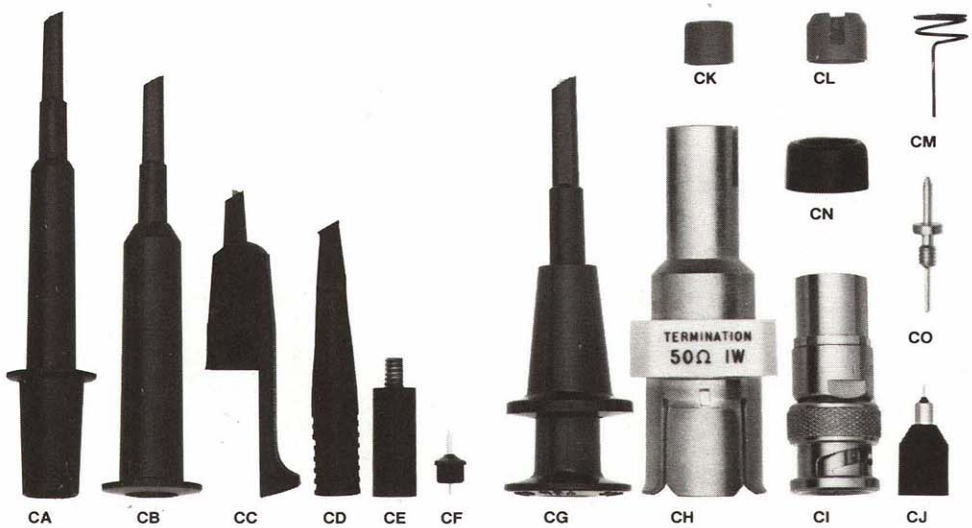
**Minimum acceptable order is $25.00.**

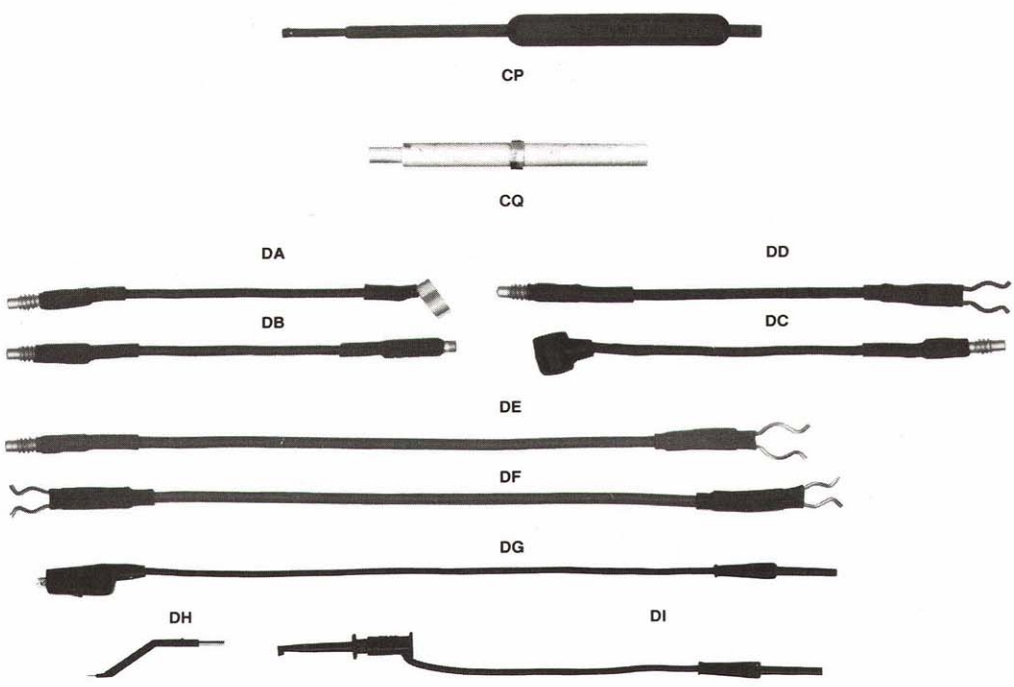
## OTHER ADAPTORS

| CODE | DESCRIPTION | PART NUMBER | PRICE |
|---|---|---|---|
| CA | Retractable hook tip (for P6010 and P6048) | 013-0090-00 | $5.00 |
| CB | Retractable hook tip (for S-3A, P6202, and P6420) | 013-0097-01 | $8.50 |
| CC | Retractable hook tip (for 7A11 and P6401) | 013-0106-00 | $11.50 |
| CD | Retractable hook tip (for 211, 212, 213, 214, 221) | 013-0107-02 | $3.25 |
| CE | Miniature probe to #6-32 adaptor (for P6045, P6046, P6202, 7A11, S-3A) | 103-0051-00 | $4.00 |
| CF | Replaceable probe tip for P6202 and P6420, pkg of 10 | 206-0230-03 | $17.00 |

## P6201 ACCESSORIES

| CODE | DESCRIPTION | PART NUMBER | PRICE |
|---|---|---|---|
| CG | Retractable probe tip (for P6201 only) | 013-0135-00 | $5.25 |
| CH | P6201 probe tip to GR 50 Ω termination adaptor | 017-0094-00 | $70 |
| CI | Probe tip to BNC adaptor (for P6201 only) | 013-0145-00 | $18 |
| CJ | Probe tip to test point jack (for P6201 only) | 103-0164-00 | $7.50 |
| CK | Insulating sleeve, electrical (for P6201 only) | 166-0557-00 | $1.00 |
| CL | Ground contact insulator (for P6201 only) | 342-0180-00 | $1.00 |
| CM | Ground contact (for P6201 only) | 131-1302-00 | $1.15 |
| CN | Ground lead, insulating sleeve (for P6201 only) | 166-0433-00 | $1.00 |
| CO | Replaceable probe tip (for P6201 only) | 206-0200-00 | $1.00 |




## PROBE TOOLS

| CODE | DESCRIPTION | PART NUMBER | PRICE |
|---|---|---|---|
| CP | Adjustment tool, probe | 003-0675-01 | $2.50 |
| CQ | Probe tip extractor | 003-0825-00 | $3.95 |

## GROUND LEADS

| CODE | DESCRIPTION | LENGTH (in) | PART NUMBER | PRICE |
|---|---|---|---|---|
| DA | Ground lead for S-3A, P6056, P6057 | 3 | 175-0249-00 | $5.00 |
| DB | Ground leads for P6054, P6075 | 3 | 175-0848-00 | $2.25 |
| | 7A11, and P6201 | 5 | 175-0848-01 | $1.75 |
| | | 12 | 175-0848-02 | $2.00 |
| DC | Ground leads for P6202 and P6420 | 3 | 175-0849-00 | $6.00 |
| | | 6 | 175-0849-01 | $6.00 |
| DD | Ground lead*1 | 3 | 175-0263-01 | $2.30 |
| | Ground lead*1 | 5 | 175-0124-01 | $2.30 |
| | Ground lead*1 | 12 | 175-0125-01 | $2.30 |
| DE | Ground leads for S-3A, P6202, P6420 | 6 | 175-1017-00 | $3.50 |
| DF | Ground lead for P6055 | 6 | 175-1256-00 | $5.00 |
| DG | Alligator clip for P6230, P6120, P6130 families | | 195-1870-00 | $6.00 |
| DH | Subminiature Low Impedance for P6230, P6130 families | | 195-4240-00 | $2.40 |
| DI | Microhook for P6230, P6120, P6130 families | | 195-4104-00 | $7.00 |

**1 For the P6053B, P6054A, P6075A, P6101, P6105, P6106, P6108, P6149, and other probes requiring clip-on ground leads.*

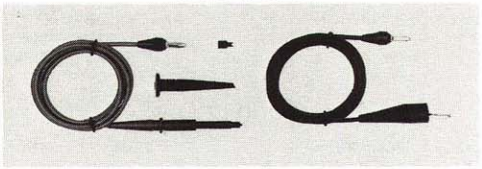
## CABLE MARKER SETS (Not Pictured)

| DESCRIPTION | PART NUMBER | PRICE |
|---|---|---|
| For 1/8 in dia cable | 016-0130-00 | $7.00 |
| For 3/16 in dia cable | 016-0127-00 | $6.00 |
| For all modular cables | 016-0633-00 | $4.00 |

**To order, call direct to your local Central Parts Ordering desk. See page 12 for the toll-free number for your area.**

**Minimum acceptable order is $25.00.**

## TEST LEADS



| | | |
|---|---|---|
| Test Lead, Black, 4 ft | 012-0425-00 | $12.00 |
| Test Lead, Red, 4 ft | 012-0426-00 | $22.00 |
| Test Lead, Black, 4 ft | 012-0426-01 | $22.00 |
| Test Lead set includes 012-0425-00, 012-0426-00,and 013-0107-03 | 012-0427-00 | $29.00 |

## LOGIC PROBE TEST LEADS

| | | |
|---|---|---|
| 16 pin low profile dip clip (can be used with 14 or 16 pin ICs) | 015-0330-00 | $40.00 |
| 10 wide comb set (grabber tips not included) | 012-0747-00 | $50.00 |

## PERSONALITY MODULE TEST LEADS

| | | |
|---|---|---|
| 40 Pin Dip Clip—10 cm cable (order M/F adaptor below) | 015-0339-00 | $44.00 |
| 40 Pin Dip Clip—30 cm cable | | |
| Male Adaptor for 40 Pin (order M/F adaptor below) | 015-0339-02 | $44.00 |
| Male Adaptor for 40 Pin Low Profile Dip Clip | 380-0560-05 | $15.00 |
| Female Adaptor for 40 Pin Low Profile Dip Clip | 380-0647-01 | $36.00 |

## PATCH CORDS

| | | |
|---|---|---|
| **BNC to BNC, 18 in** | | |
| Red | 012-0087-00 | $7.00 |
| Black | 012-0086-00 | $7.00 |
| **BNC to banana plug-jack, 18 in** | | |
| Red | 012-0091-00 | $7.00 |
| Black | 012-0090-00 | $7.00 |
| **Banana plug-jack to banana plug-jack, 18 in** | | |
| Red | 012-0031-00 | $7.00 |
| Black | 012-0039-00 | $8.00 |
| **Pin-jack to pin-jack, 0.08 in dia pin** | | |
| Red, 8 in | 012-0179-00 | $3.75 |
| Red, 18 in | 012-0180-00 | $3.75 |
| Black, 8 in | 012-0181-00 | $3.75 |
| Black, 18 in | 012-0182-00 | $4.25 |

## COAXIAL CABLES BNC

| | | |
|---|---|---|
| Coaxial, 50 Ω, 42 in | 012-0057-01 | $17.00 |
| Coaxial, 75 Ω, 42 in | 012-0074-00 | $17.50 |
| Coaxial, 93 Ω, 42 in | 012-0075-00 | $29.00 |
| Coaxial, 50 Ω, 18 in | 012-0076-00 | $17.00 |
| Coaxial, 50 Ω, 18 in, Male to Female | 012-0104-00 | $25.00 |
| Coaxial, 50 Ω ±1% Precision, 36 in | 012-0482-00 | $25.00 |

## BSM

| | | |
|---|---|---|
| BSM Female to BNC Male Coaxial, 10 in, RG58 | 012-0128-00 | $20.00 |
| BSM Female to BNC Male Coaxial, 18 in, RG58 | 012-0127-00 | $23.00 |

## GR 50 Ω

| | | |
|---|---|---|
| Coaxial 10 ns RG58A/U | 017-0501-00 | $85.00 |
| Coaxial 5 ns RG213/U | 017-0502-00 | $175.00 |
| Coaxial 1 ns RG58A/U*[1] | 017-0503-00 | $100.00 |
| Coaxial 2 ns RG58A/U | 017-0505-00 | $120.00 |
| Coaxial 5 ns RG58A/U | 017-0512-00 | $90.00 |
| Coaxial 10 in RG213/U | 017-0513-00 | $80.00 |
| Coaxial 20 in RG213/U | 017-0515-00 | $95.00 |

*[1] Connector on one end only.*

## N 50 Ω

| | | |
|---|---|---|
| Coaxial N Connectors, 6 ft | 012-0114-00 | $25.00 |

## SMA (3 mm) 50 Ω

| | | |
|---|---|---|
| Coaxial, 2 ns, Male to Female | 015-1005-00 | $90.00 |
| Coaxial, 5 ns, Male to Female | 015-1006-00 | $140.00 |
| Coaxial semirigid 500 ps, 4.5 in male only | 015-1015-00 | $25.00 |
| Coaxial semirigid 750 ps, | 015-1017-00 | $35.00 |
| Coaxial, 1 ns | 015-1019-00 | $120.00 |

## 50 Ω AIR LINE

The 20 cm 50 Ω air line is useful as a time-delay device and as an absolute impedance in a time-domain reflectometer system. The characteristic impedance is 50 Ω ±0.4%. Time delay is 0.6698 ns ±0.4%.

| | | |
|---|---|---|
| 50 Ω Air Line | 017-0084-00 | $165.00 |

## ADAPTORS

| | | |
|---|---|---|
| BNC Female to BNC Female | 103-0028-00 | $5.00 |
| BNC Male to BNC Male | 103-0029-00 | $5.50 |
| BNC T | 103-0030-00 | $6.50 |
| BNC Elbow Male to Female | 103-0031-00 | $7.50 |

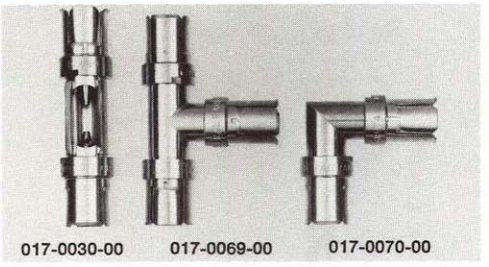
| | | |
|---|---|---|
| BNC Male to GR | 017-0064-00 | $75.00 |
| BNC Male to UHF Female | 103-0032-00 | $5.00 |
| BNC Male to Binding Post | 103-0033-00 | $5.00 |
| BNC Male to Dual Binding Post | 103-0035-00 | $12.00 |
| BNC Male to N Female | 103-0058-00 | $7.00 |

| | | |
|---|---|---|
| BNC Female to clip leads | 013-0076-00 | $25.00 |
| BNC Female to GR | 017-0063-00 | $43.00 |
| BNC Female to uhf Male | 103-0015-00 | $4.50 |
| BNC Female to BSM Male | 103-0036-00 | $15.00 |
| BNC Female to N Male | 103-0045-00 | $6.50 |
| BNC Female to Dual Banana | 103-0090-00 | $7.50 |
| BNC Female to EZ Ball | 013-0076-01 | $17.50 |

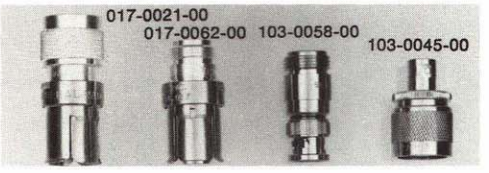
| | | |
|---|---|---|
| Female to BNC Male | 013-0126-00 | $16.00 |
| "F" Female to GR874 | 017-0089-00 | $50.00 |
| "F" Male to "F" Male | 103-0157-00 | $7.50 |
| "F" Male to BNC Female | 103-0158-00 | $9.00 |
| "F" Female to "F" Female | 103-0159-00 | $7.50 |

**Minimum acceptable order is $25.00.**

| | | |
|---|---|---|
| GR to BNC Female | 017-0063-00 | $43.00 |
| GR to BNC Male | 017-0064-00 | $75.00 |
| 50 Ω termination, thru-line (GR to BNC Male) | 017-0083-00 | $85.00 |




| | | |
|---|---|---|
| GR Insertion Unit | 017-0030-00 | $80.00 |
| GR T | 017-0069-00 | $110.00 |
| GR Elbow | 017-0070-00 | $120.00 |




| | | |
|---|---|---|
| N Male to GR | 017-0021-00 | $50.00 |
| N Female to GR | 017-0062-00 | $55.00 |
| N Male to BNC Female | 103-0045-00 | $6.50 |
| N Female to BNC Male | 103-0058-00 | $7.00 |

| | | |
|---|---|---|
| SMA Male to Male | 015-1011-00 | $20.00 |
| SMA Female to Female | 015-1012-00 | $9.25 |
| SMA T | 015-1016-00 | $35.00 |
| SMA Male to BNC Female | 015-1018-00 | $8.00 |

**To order, call direct to your local Central Parts Ordering desk. See page 12 for the toll-free number for your area.**

## ACCESSORY HOUSING

Accessory housing without electrical components is useful for applications requiring special circuitry.

| | | |
|---|---|---|
| Accessory Housing | 011-0081-00 | $30.00 |

## ATTENUATORS—TERMINATIONS

**BNC**

| | | |
|---|---|---|
| 50 Ω ±0.1% precision feed-through termination (dc −100 kHz, 11 V RMS maximum) | 011-0129-00 | $95.00 |
| 50 Ω feed through termination*1 | 011-0049-01 | $25.00 |
| 50 Ω 10X (20 dB) attenuator*2 | 011-0059-02 | $35.00 |
| 50 Ω 5X (14 dB) attenuator*2 | 011-0060-02 | $35.00 |
| 50 Ω (6 dB) attenuator*2 | 011-0069-02 | $35.00 |
| 50 Ω 2.5X (8 dB) attenuator*2 | 011-0076-02 | $35.00 |
| 50 Ω feedthrough termination (5 W)*3 | 011-0099-00 | $40.00 |

**vswr**

**1 <1.1 dc −250 MHz and <1.2 dc −500 MHz.*
**2 <1.1 dc −1.0 GHz and <1.2 dc −2.0 GHz.*
**3 1.1 dc −100 MHz.*

**Characteristics** — Dc resistance is 50 Ω ±1 Ω. Attenuation accuracy is ±2% dc, ±5% at 2 GHz. Power rating (except 011-0099-00) is 2 W average.

| | | |
|---|---|---|
| 75 Ω feedthrough termination | 011-0055-01 | $25.00 |
| 93 Ω feedthrough termination | 011-0056-01 | $25.00 |
| 50 Ω to 75 Ω minimum loss attenuator | 011-0057-01 | $30.00 |
| 50 Ω to 93 Ω minimum loss attenuator | 011-0058-01 | $30.00 |
| 75 Ω 10X attenuator | 011-0061-00 | $32.00 |
| 93 Ω 10X attenuator | 011-0062-00 | $30.00 |
| 600 Ω feedthrough termination (1 W, dc to 1 MHz) | 011-0092-00 | $30.00 |
| 75 Ω to 50 Ω minimum loss attenuator (ac coupled) | 011-0112-00 | $60.00 |

**Characteristics** — Accuracy of indicated attenuation ratio is ±2% at dc. Power rating of attenuators is ½ W and terminations 1 W. Voltage standing wave ratio (vswr) not specified.

**GR 50 Ω**

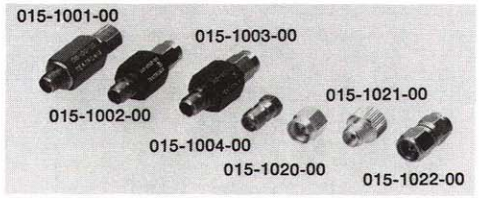
| | | |
|---|---|---|
| 50 Ω 10X attenuator | 017-0078-00 | $220.00 |
| 50 Ω 5X attenuator | 017-0079-00 | $240.00 |
| 50 Ω 2X attenuator | 017-0080-00 | $190.00 |
| 50 Ω termination, end-line | 017-0081-00 | $135.00 |

**Characteristics** — Accuracy of indicated attenuation ratio is ±2% at dc, ±3% at 1 GHz. Voltage standing wave ratio (vswr) is <1.1 up to 1 GHz. Power rating is 1 W.

**N 50 Ω**

| | | |
|---|---|---|
| 10 dB attenuator | 011-0085-00 | $70.00 |
| 20 dB attenuator | 011-0086-00 | $70.00 |
| 40 dB attenuator | 011-0087-00 | $90.00 |

**Characteristics** — Frequency range is dc to 12.4 GHz. Power rating is 2 W average, 300 W peak. Impedance is 50 Ω ±1.0 dB.




**SMA (3 mm) 50 Ω**

| | | |
|---|---|---|
| 50 Ω 2X attenuator | 015-1001-00 | $120.00 |
| 50 Ω 5X attenuator | 015-1002-00 | $120.00 |
| 50 Ω 10X attenuator | 015-1003-00 | $120.00 |
| 50 Ω termination Female | 015-1004-00 | $60.00 |
| Short-Circuit termination Male | 015-1020-00 | $17.50 |
| Short-Circuit termination Female | 015-1021-00 | $24.00 |
| 50 Ω termination Male | 015-1022-00 | $32.00 |

**Characteristics**

| | Dc—12.40 GHz | | 12.41—18.00 GHz | | Power |
|---|---|---|---|---|---|
| | Attenuation | | Attenuation | | Continuous |
| | Accuracy | Vswr | Accuracy | Vswr | |
| Termination | ±1 Ω | 1.15 | ±1 Ω | 1.15 | 0.5 W |
| 2X (6 dB) | ±0.75 dB | 1.40 | ±1.00 dB | 2.00 | 1.0 W |
| 5X (14 dB) | ±0.75 dB | 1.40 | ±1.00 dB | 1.60 | 1.0 W |
| 10X (20 dB) | ±0.75 dB | 1.40 | ±1.00 dB | 1.60 | 1.0 W |

## 50 Ω COUPLING CAPACITOR

The coupling capacitor is a short length of coaxial line with a disk capacitor (4700 pF, ±20%) in series with the inner conductor. Reflection ratio (in 150 ps tdr system), is 0.03 maximum. Voltage rating is 200 V.

| | | |
|---|---|---|
| Coupling Capacitor SMA (3 mm) | 015-1013-00 | $200.00 |

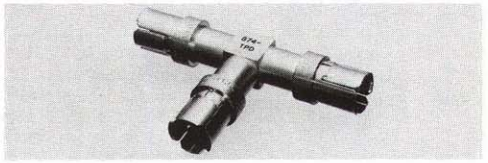
The coupling capacitor is a short length of coaxial line having a disk capacitor (4700 pF) in series with the inner connector. High frequencies are transmitted with small reflection, but dc and low frequencies are blocked. Voltage rating is 500 V.

| | | |
|---|---|---|
| Coupling Capacitor GR | 017-0028-00 | $100.00 |

## 50 Ω POWER DIVIDERS

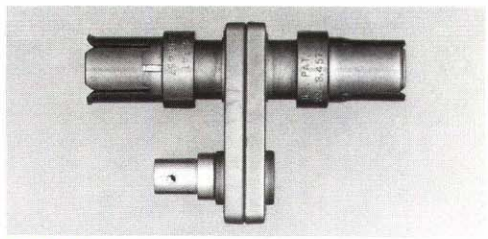
This coaxial tee is designed for use in broad-band 50 Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. Load isolation is nominally 6 dB while the voltage attenuation ratio is nominally 2X (input to either load arm, other load arm terminated in a standard 50 Ω termination). Maximum vswr is 1.50 from dc to 12.00 GHz and 1.90 from 12.01 to 18.00 GHz.

| | | |
|---|---|---|
| Power Divider SMA (3 mm) | 015-1014-00 | $200.00 |



This coaxial tee has a 16.67 Ω resistor in each leg, connected so that the tee looks like 50 Ω if two legs are terminated in 50 Ω. It is designed for use in broad-band 50 Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. It is especially useful in a time-domain reflectometer set-up where test line, pulser, and oscilloscope must be coupled with a minimum of reflection-producing discontinuities.

| | | |
|---|---|---|
| Power Divider GR | 017-0082-00 | $375.00 |



## CT-3 Signal Pickoff

Design for use with high-frequency oscilloscopes, the CT-3 Pickoff provides a convenient means of picking off a signal in a 50 Ω system. Used with any of the Tektronix sampling instruments, the CT-3 provides the link for use as a trigger source.

**Sensitivity** — 10% of the voltage under test, into a 50 Ω load.
**Decay Time Constant** — 4.5 μs at 0 dc current.
**Risetime** — <0.4 ns.
**Frequency Response** — 50 kHz to 875 MHz at 0 dc current.
**Insertion Impedance** — With 50 Ω termination is 1 Ω shunted by 4.5 μH, 2 Ω shunted by 4.5 μH without a 50 M termination.
**Vswr** — <1.2 at 1.5 GHz.
**Voltage Rating** — At 0 V dc is 25 V RMS. 1 kV pulse peak. The V's product is 100 V μs. If exceeded, the L/R decay will decay rapidly toward zero.

### ORDERING INFORMATION

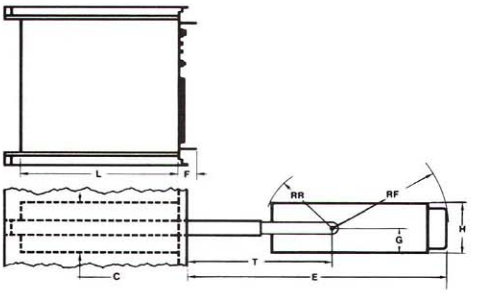
**CT-3** Signal Pickoff. Order 017-0061-00 ..... **$150.00**

**To order, call direct to your local Central Parts Ordering desk. See page 12 for the toll-free number for your area.**

## MOUNTING DIMENSIONS

| PRODUCT | H | | L | | F | | G | | E | | RF | | RR | | T | | C | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | in | cm | in | cm | in | cm | in | cm | in | cm | in | cm | in | cm | in | cm | in | cm |
| R434 | 5.3 | 13.5 | 18.0 | 45.7 | 1.6 | 4.0 | — | — | — | — | — | — | — | — | — | — | 5.3 | 13.5 |
| R485*1 | 7.0 | 17.8 | 16.2 | 41.1 | 1.8 | 4.6 | 3.5 | 8.9 | 19.3 | 49.0 | 10.9 | 27.7 | 7.9 | 20.1 | 9.3 | 23.6 | 6.8 | 17.3 |
| R5100<br>R5400*1 | 5.3 | 13.5 | 19.0 | 48.3 | 1.1 | 2.8 | 1.8 | 4.6 | 24.6 | 62.5 | — | — | — | — | — | — | 5.3 | 13.5 |
| R5223 | 7.0 | 17.8 | 20.8 | 52.9 | 1.3 | 3.3 | — | — | — | — | — | — | — | — | — | — | 7.0 | 17.8 |
| R7103 | 7.0 | 17.8 | 27.7 | 70.4 | 1.5 | 3.8 | — | — | 29.0 | 73.7 | — | — | — | — | — | — | 7.0 | 17.8 |
| R7704*1 | 7.0 | 17.8 | 22.4 | 56.9 | 2.3 | 5.8 | 1.8 | 4.6 | 33.3 | 84.6 | 15.3 | 38.9 | 10.7 | 27.2 | 18.5 | 47.0 | 7.0 | 17.8 |
| R7313*1<br>R7603*1<br>R7613*1<br>R7623*1 | 5.3 | 13.5 | 22.3 | 56.6 | 2.0 | 5.1 | — | — | 25.2 | 64.0 | — | — | — | — | — | — | 5.3 | 13.5 |
| R7844*1 | 7.0 | 17.8 | 24.8 | 63.0 | 2.3 | 5.8 | 1.75 | 4.4 | — | — | — | — | — | — | — | — | 7.0 | 17.8 |
| R7903*1 | 5.3 | 13.5 | 22.8 | 57.9 | 2.3 | 5.8 | — | — | 25.3 | 64.3 | — | — | — | — | — | — | 5.3 | 17.8 |
| R7912*1 | 5.3 | 13.5 | 26.9 | 68.3 | 1.8 | 4.6 | — | — | 26.9 | 68.3 | — | — | — | — | — | — | 5.3 | 13.5 |
| 7912AD | 7.0 | 17.8 | 26.0 | 66.0 | 1.95 | 5.0 | — | — | 30.7 | 78.0 | — | — | — | — | — | — | 6.9 | 17.5 |
| RTM506 | 5.25 | 13.3 | 18.9 | 48.0 | 1.82 | 4.7 | — | — | — | — | — | — | — | — | — | — | 5.25 | 13.3 |
| T922R | 5.2 | 13.2 | 17.0 | 43.2 | 1.7 | 4.3 | — | — | 24.2 | 61.5 | — | — | — | — | — | — | 5.2 | 13.2 |
| 016-0015-00 | 5.1 | 13.0 | 16.3 | 41.4 | 1.8 | 4.5 | — | — | — | — | — | — | — | — | — | — | — | — |
| 016-0115-02 | 5.3 | 13.5 | 16.3 | 41.4 | 0.3 | 0.8 | — | — | — | — | — | — | — | — | — | — | 5.3 | 13.5 |
| 016-0466-00 | 5.1 | 13.0 | 16.3 | 41.4 | 1.8 | 4.5 | — | — | — | — | — | — | — | — | — | — | — | — |
| 016-0468-00 | 5.2 | 13.3 | 14.9 | 37.8 | 2.0 | 5.1 | — | — | — | — | — | — | — | — | — | — | — | — |
| 016-0675-00*1 | 8.8 | 22.4 | 19.7 | 50.1 | 1.5 | 3.9 | 3.5 | 8.9 | 24.3 | 61.6 | — | — | 11.9 | 30.1 | 13.3 | 33.8 | 8.5 | 21.6 |
| 016-0676-00*1 | 7.0 | 17.8 | 19.7 | 50.1 | 1.9 | 4.8 | 3.5 | 8.9 | 24.3 | 61.6 | 11.1 | 28.2 | 11.2 | 28.4 | 13.3 | 33.8 | 6.9 | 17.5 |
| 016-0691-00*1 | 7.0 | 17.8 | 18.3 | 46.5 | 1.5 | 3.9 | 3.5 | 8.9 | 20.4 | 51.9 | 11.8 | 30.0 | — | — | 9.5 | 24.1 | 6.6 | 16.7 |
| 040-0551-01 | 14.0 | 35.6 | 22.4 | 56.9 | 0.6 | 1.5 | — | — | 30.9 | 78.5 | — | — | — | — | — | — | — | — |
| 040-0600-00 | 5.25 | 13.3 | 18.3 | 46.5 | 0.7 | 1.8 | — | — | — | — | — | — | — | — | — | — | 5.25 | 13.3 |
| 040-0601-00 | 5.25 | 13.3 | 18.3 | 46.5 | 0.7 | 1.8 | — | — | — | — | — | — | — | — | — | — | 5.3 | 13.5 |
| 040-0616-02 | 5.3 | 13.5 | 16.5 | 41.9 | 1.1 | 2.8 | 1.8 | 4.6 | 24.6 | 62.5 | — | — | — | — | — | — | 5.25 | 13.3 |
| 040-0617-02 | 5.3 | 13.5 | 16.5 | 41.9 | 1.1 | 2.8 | 1.8 | 4.6 | 24.6 | 62.5 | — | — | — | — | — | — | 5.3 | 13.5 |
| 040-0624-01 | 5.25 | 13.3 | 18.3 | 46.5 | 0.7 | 1.8 | — | — | — | — | — | — | — | — | — | — | 5.3 | 13.5 |
| 437-0031-00 | 8.8 | 22.4 | 9.5 | 24.1 | 0.3 | 0.8 | — | — | — | — | — | — | — | — | — | — | 5.25 | 13.3 |
| 437-0071-00 | 7.0 | 17.8 | 13.4 | 34.0 | 1.4 | 3.6 | — | — | — | — | — | — | — | — | — | — | 7.1 | 18.0 |
| 437-0126-03 | 5.3 | 13.5 | 22.3 | 56.6 | 2.0 | 5.1 | — | — | 25.2 | 64.0 | — | — | — | — | — | — | 6.6 | 16.8 |

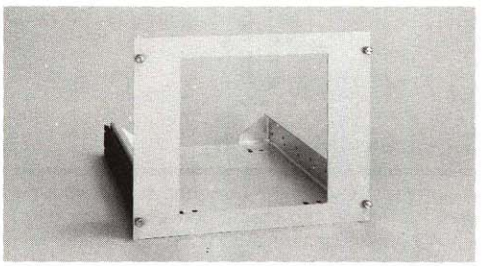
*1 *These instruments mount with sliding tracks to a standard 19-inch wide rack. Rear support for sliding tracks is required, such as an enclosed rack.*




### DIMENSIONS EXCLUSIVE OF PLUG-IN UNITS AND PROBES

| Symbol | Definition |
|---|---|
| H | Height of front panel |
| L | Rack front to rearmost permanent fixture excluding cables |
| F | Back of front panel to foremost protrusion |
| G | Bottom of front panel to horizontal plane of rotation |
| E | Maximum forward clearance with instrument out and horizontal |
| RF | Front radius of rotation |
| RR | Rear radius of rotation |
| T | Rack front to pivot point |
| C | Cabinet height |

### RACK ADAPTORS



For rackmounting the 7000 Series oscilloscopes in a standard 19 in wide rack. Rack adaptor includes slide-out assemblies. 7000 Series mask finish is light gray.

**For 7704A, 7104, 7834 and 7854,** rack height is 15.75 in, rack depth is 21.38 in, shipping weight is ≈41 lb. Order 040-0611-01 ..... **$480**

**For 455 and 465M,** includes cradle mount, rack height 7 in, rack depth 18.75 in. Order 040-0825-01 ..... **$435**

**For 2445 and 2465.** Order 016-0691-01 ..... **$305**

**For 2335.** Order 016-0468-00 ..... **$250**

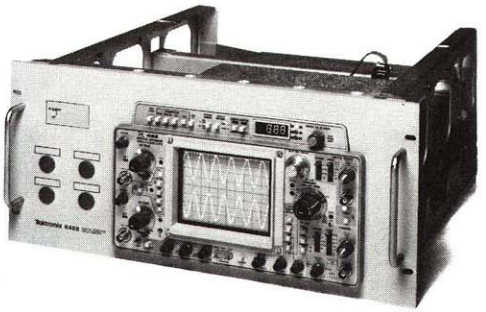
**For 2213A, 2215A and 2235.** Order 016-0466-00 ..... **$100**

**For 2236.** Order 016-0015-00 ..... **$200**

**For 464 and 466.** Order 016-0676-00 ..... **$350**

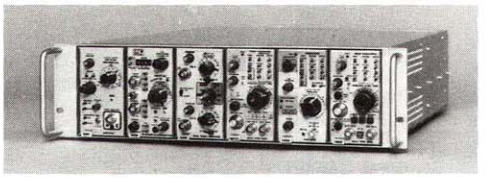
**For 485.** Order 016-0558-00 ..... **$395**

**For 434.** Order 016-0272-00 ..... **$250**



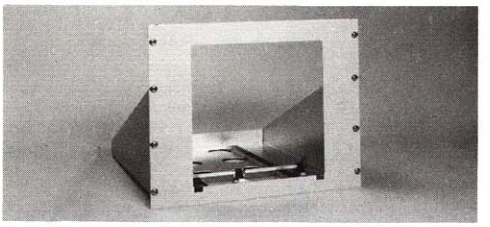
**For 468.** Order 016-0675-00 ..... **$350**

### STORAGE CABINETS



**For 7000 Series Plug-in Units** — Holds 6 plug-in units, for mounting in a 19 in rack, 5.25 in high. Order 437-0126-03 ..... **$825**

### CRADLE MOUNTS



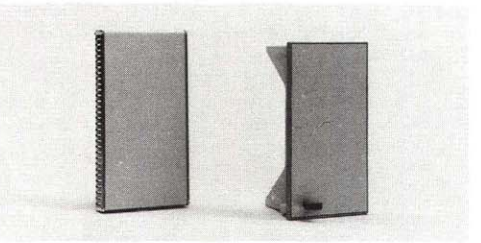
For rackmounting 7000 Series cabinet-type oscilloscopes in a standard 19 in wide rack. Cradle mount consists of a cradle (or "shelf") without slide-out assemblies and a mask to fit over the regular instrument panel. 7000 Series mask finish is light gray.

**For 7704A,** rack height is 15.75 in, rack depth is 22 in, shipping weight is ≈16 lb. Order 040-0560-00 ..... **$445**

**To order, call direct to your local Central Parts Ordering desk. See page 12 for the toll-free number for your area.**

**Minimum acceptable order is $25.00.**

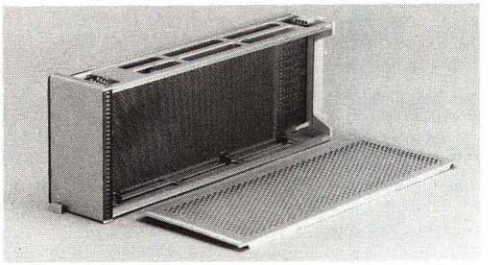
### BLANK PANEL



**Blank Panel** — When operating the 5000/7000 Series mainframes or the TM 500 or TM 5000 Series mainframes with less than a full complement of plug-ins, the blank panel may be used to cover an unused compartment. The panel for the 7000 Series is also good for EMC Shielding.

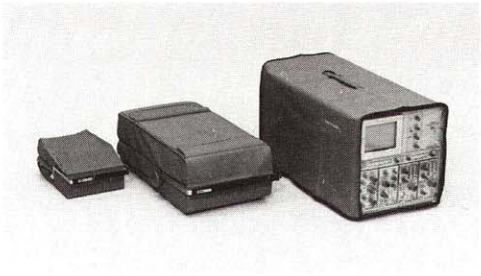
**7000 Series.** Order 016-0155-00 ..... **$50**
**5000 Series.** Order 016-0452-00 ..... **$21**
**TM 500/TM 5000 Series.** Order 016-0195-03 ..... **$25**

### BLANK PLUG-IN CHASSIS



**Blank Plug-in Chassis** — Available for all Tektronix mainframes. The 7000 Series provides a printed circuit board, plug-in frame, and securing hardware. The 560 Series, 1-Series, and Letter Series plug-in chassis have an interconnecting plug, securing hardware and plug-in frame.

**7000 Series.** Order 040-0553-03 ..... **$145**
**5000 Series.** Order 040-0818-03 ..... **$105**
**TM 500 Series.** Order 040-0652-05 ..... **$95**
**560 Series.** Order 040-0245-00 ..... **$150**



## OSCILLOSCOPE PROTECTIVE COVERS

The cover provides protection for the oscilloscope during transport or storage. Made of waterproof blue vinyl, the covers are available for both laboratory and portable instruments. The covers for 500, 5000, and 7000 Series laboratory oscilloscopes have clear vinyl frontal areas.

**PROTECTIVE COVERS**

| INSTRUMENT | PART NUMBER | PRICE |
|---|---|---|
| 200 Series | 016-0512-00 | $15.00 |
| 323,324,1401A,1401A-1, 1501 | 016-0112-00 | $8.25 |
| 314,335 | 016-0612-00 | $60.00 |
| 326 | 016-0532-00 | $46.00 |
| 453A,454A,491 | 016-0074-01 | $18.00 |
| 434,464,466 | 016-0365-00 | $21.00 |
| 465,465B,475,485 | 016-0554-00 | $17.00 |
| 5000 Series | 016-0544-00 | $18.00 |
| 7300,7400,7600 Series | 016-0192-01 | $20.00 |
| 7704A,7900 | 016-0531-00 | $15.00 |

## PLUG-IN UNIT CARRYING CASES

**3-Wide Carrying Case** for 7L14, 7L5 Option 25, 7D20, 7L18. Order 016-0626-00 ..... **$330**

**2-Wide Carrying Case** for 7L12, 7L5. Order 016-0625-00 ..... **$290**

## CRT MESH FILTERS

The mesh filter improves display contrast for oscilloscope viewing under high ambient light conditions.

A fine metal screen with a matte black surface is utilized to reduce light reflections. Although light transmission from the CRT is reduced to approximately 28%, the high attenuation of external reflections allows viewing low-intensity displays in room light or other bright surroundings.

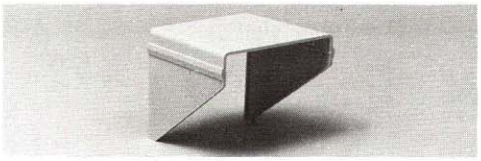
The mesh filter also serves as an EMC filter. Installed on the instrument, the metal frame of the filter is grounded, providing effective filtering of the EMC spectrum.

| INSTRUMENT*[1] | PART NUMBER | PRICE |
|---|---|---|
| 314, 326, 335 | 378-0063-00 | $21.00 |
| 432, 434 | 378-0682-00 | $48.00 |
| 422, 491, 453A, 454A, 485 | 378-0648-00 | $30.00 |
| 465, 465B, 475, 464, 466, 434 | 378-0726-01 | $55.00 |
| 7400, 7603 | 378-0696-00 | $55.00 |
| 7100, 7500, 7700, 7800, 7900 Series and 7613, 7623, 7633 | 378-0603-00 | $55.00 |

*[1] *For both cabinet and rackmount instruments.*

## VIEWING ACCESSORIES

The viewing accessories listed normally mount on the oscilloscope graticule cover. In many cases, they will also fit camera-mounting bezels. If you intend using a camera on your oscilloscope, check with your Tektronix Sales Engineer for bezel-viewer compatibility before ordering.



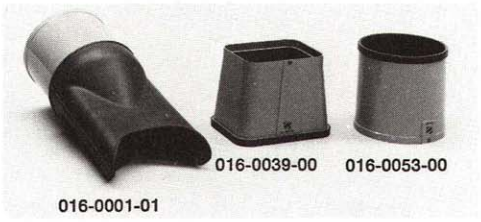
**View Hood (Folding)** — 314, 326, 335, 400 Series, 576, 577, 5000, and 7000 Series oscilloscopes.

**For 576.** Order 016-0259-00 ..... **$23**

**For 577, 5000, and 7000 Series.** Order 016-0260-00 ..... **$21**

**For 326, 314, 335, SC 502, SC 504** (not pictured). Order 016-0297-00 ..... **$2.00**

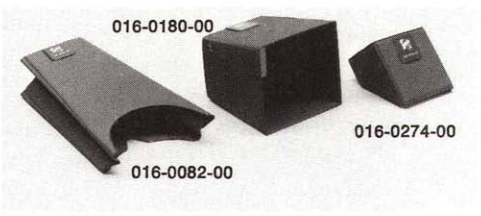
**For 464, 466, 455** (not pictured). Order 016-0592-00 ..... **$12**




**Polarized Viewers** — For Tektronix older 5 inch oscilloscopes. The viewers reduce troublesome reflections and glare under high ambient light conditions.

**Rectangular Viewer.** Order 016-0039-00 ..... **$80**
**Plastic Round Viewer.** Order 016-0053-00 ..... **$42**

**Viewing Hood** — For Tektronix older 5 inch round oscilloscopes. Includes molded rubber eyepiece and separate tubular light shield. Order 016-0001-01 ..... **$145**



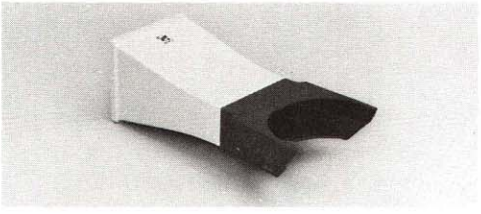

**Collapsible Viewing Hood** — For oscilloscopes with rectangular CRTs. Blue vinyl material, folds flat for convenient storage.

**For 422, 453A, 454A, 485, 491.** Order 016-0082-00 ..... **$15**

**For 422, 453A, 454A, 485, 491.** Order 016-0274-00 ..... **$15**

**Viewing Hood (Folding Binocular)** — For some 400 Series. **For 434, 455, 464, 466, 465B, 475 and 475A.** Order 016-0566-00 ..... **$15**

**Polarized Collapsible Viewing Hood** — To reduce reflections and glare under high ambient light conditions. **For 432, 434, 455, 465, 465B, 475, 464, 466, 2445, 2465.** Order 016-0180-00 ..... **$40**



**Viewing Hood** — Molded gray polystyrene with polyurethane eyepiece.

**For 576.** Order 016-0153-00 ..... **$44**

**For 5000 and 7000 Series, 601, 602, 603, 604, 528 and 577.** Order 016-0154-00 ..... **$28**

## CATHODE-RAY TUBE LIGHT FILTERS

| INSTRUMENT*[1] | COLOR | PART NUMBER | PRICE |
|---|---|---|---|
| 200 Series | Blue | 378-0691-00 | $1.50 |
| 314,335 | Blue | 378-2016-01 | $1.80 |
| 434 | Blue | 378-0678-01 | $2.00 |
| 455,465M | Blue | 337-2122-00 | $5.00 |
| 465,465B,475, 464,466 | Blue | 337-1674-00 | $5.00 |
| | Clear | 337-1674-01 | $5.00 |
| | Smoke-gray filter | 337-1674-07 | $5.00 |
| 540,550 Series 565,575 | Smoke-gray† | 378-0567-00 | $9.00 |
| | Green | 378-0568-00 | $4.50 |
| | Blue | 378-0569-00 | $4.50 |
| | Amber | 378-0570-00 | $4.50 |
| 576 | Blue† | 378-0616-00 | $5.00 |
| 603,604 | Clear (603†) | 337-1440-00 | $3.00 |
| | Green | 337-1440-01 | $3.00 |
| | Amber | 337-1440-02 | $3.50 |
| | Blue | 337-1440-03 | $3.50 |
| | Gray | 337-1440-04 | $4.50 |
| | Graticule (8x10 div) | 331-0303-00 | $15.00 |
| 605,606,607 | Blue | 337-1674-00 | $5.00 |
| | Graticule | 337-1674-10 | $10.00 |
| | Clear Shield | 337-1674-13 | $10.00 |
| | Gray† | 337-1674-06 | $5.00 |
| | Graticule (8x10 div) | 331-0391-00 | $9.00 |
| 608 | Amber | 378-0704-00 | $10.00 |
| | Graticule† | 337-2126-02 | $10.00 |
| 2200 Series | Blue† | 337-2775-00 | $3.00 |
| 2300 Series | Blue Implosion Shield† | 337-2760-00 | $1.65 |
| | Clear Implosion Shield† | 337-2781-00 | $4.40 |
| 2400 Series | Blue† | 378-0199-00 | $1.50 |
| | Clear Implosion Shield† | 378-0208-00 | $1.50 |
| 5100 and 5400 Series (except 5441) | Clear | 337-1440-00 | $3.00 |
| | Green | 337-1440-01 | $3.00 |
| | Amber | 337-1440-02 | $3.50 |
| | Blue | 337-1440-03 | $3.50 |
| | Gray | 337-1440-04 | $4.50 |
| 5441 | Clear† | 337-1674-01 | $5.00 |
| | Gray | 337-1674-06 | $5.00 |
| | Graticule (8x10 div) | 331-0391-00 | $9.00 |
| 7603 | Blue | 378-0684-00 | $7.00 |
| | Amber | 378-0684-01 | $7.00 |
| | Gray | 378-0684-02 | $7.00 |
| | Green | 378-0684-03 | $7.00 |
| | With Spectrum Analyzer Graticule | 337-1439-01 | $8.00 |
| | Blue Implosion Shield† | 337-1700-01 | $5.50 |
| | Clear Implosion Shield | 337-1700-04 | $5.50 |
| 7613,7623 7623A,7633 | Spectrum Analyzer Green (UV) | 378-0625-07 | $9.50 |
| | | 378-0625-08 | $5.00 |
| 7844, 7313 7700 Series 7613, 7623 7100 Series 7900 Series | Blue† | 378-0625-00 | $5.00 |
| | Amber | 378-0625-01 | $5.00 |
| | Gray | 378-0625-02 | $5.00 |
| | Green | 378-0625-03 | $5.00 |
| | Gray TV Graticule NTSC Clear Shield | 378-0625-06 | $9.50 |
| | With Spectrum Analyzer Graticule | 337-1159-02 | $8.00 |

*[1] *For both cabinet and rackmount instruments unless rackmount version is listed.*

† *Standard filter supplied with instrument.*

**To order, call direct to your local Central Parts Ordering desk. See page 12 for the toll-free number for your area.**

**Minimum acceptable order is $25.00.**

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